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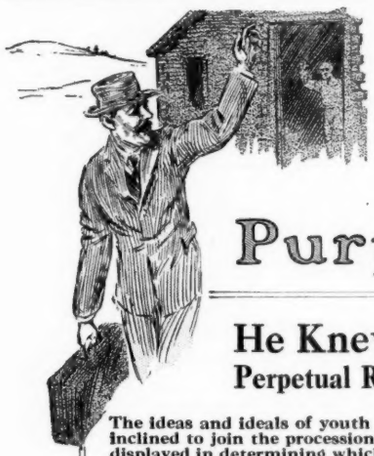
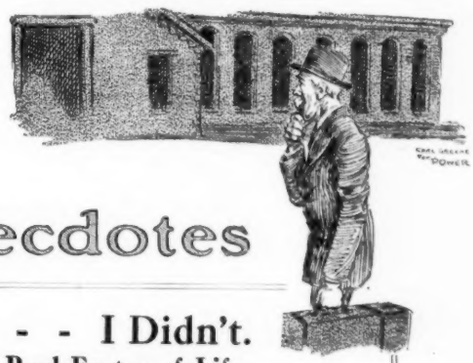




Purposeful Anecdotes

He Knew When To Stop - - - - I Didn't.

Perpetual Roving Is, with Some Folks, a Very Real Factor of Life.

The ideas and ideals of youth are easily formed and are as easily dissipated. As age comes on, men find themselves less inclined to join the processions that form on any pretext. A wise man is distinguished from a foolish man by the ability displayed in determining which processions to join, how far to journey with them, and when to leave. Some men acquire this ability early in life; a few get their eyes open just in time; and the rest just keep on moving to the end.

"SO you won't chuck the job with me, old man?"

"No, John, I don't believe I will. In fact, I know I won't. As I have told you more than once lately, I am beginning to believe that during our experience we have chucked too many jobs. We have been fortunate in always finding work together, and the constant association has built up a relationship between us that, on my part at least, is going to be hard to break. But you must realize that we are both over thirty years of age, and that if we don't soon resist the temptation to exercise our itchy feet every so often, we will soon be at an age when employers will think twice before giving us a job. Employers value the services of an old employee, but the general run of them want the age to accumulate while the man is in their employ. You see what I am driving at, don't you?"

"Yes, Al, I see your point. You may be right—and then again, you may be wrong. You know we have stuck around here longer than we ever did anywhere before. I can't see that we are any better off for the long sojourn. So, if you have made up your mind to stay awhile longer, I wish you good luck. I am going to move, much as I regret to part company with you. I will keep you posted, of course. When you get ready to make a change, let me know and we'll strike out for a job together."

Thus parted two young men, Al Williams and John Allmer. Since early childhood they had been almost inseparable companions. Having many traits in common, they had entered the same profession, and at the time of the conversation recorded above, both were employed as operating engineers in the plant of the Bellfield Paper Co., one of the largest paper factories in the New England States.

John Allmer was in Pennsylvania when Al Williams next heard from him. After a year or so in that state, he drifted successively to Illinois, Indiana, over to Canada, and then back to Pennsylvania. For about five years the two men kept up a more or less regular correspondence with each other. Then, for some reason, the letters came farther and farther apart, and finally stopped altogether.

* * *

Many years had gone since John Allmer and Al Williams parted company. Williams was still in the service of the Bellfield Paper Co. He had applied himself diligently, not only to the problems of the power plant, but to the science of paper making as well, with the result that he was now general superintendent of mechanical equipment in the seven mills of the concern.

One day a man walked into the building that, twenty years before, had housed all the power plant equipment of the Bellfield company. After looking around the plant awhile, he got into conversation with one of the watch engineers. The stranger was perhaps fifty years of age, and, while he was neatly dressed, his face had a worn, haggard expression, the look of a man who has long been in search of something and has given up hope of finding it.

After passing the time of day, the stranger asked, "Who is chief of this place now?"

"Mr. Williams is general superintendent," replied the watch engineer, "and Mr.—"

"Mr. Williams! . . . You don't mean Al Williams?"

"That's his name. Why, do you know him?"

"Why, yes, I used to. A good many years ago he and I worked together in this plant as engineers. It doesn't look much now like it did then, though. . . . Well, I'll be d——! Al Williams general superintendent! . . . Yes, at one time Williams and I were buddies. We were raised in the same town, and in our youth and young manhood were together practically all the time, even in our work. About the time we passed the thirty-year mark, Al got a notion he wasn't going to change jobs so often. We were working here then. I wanted to go and he didn't. I went and he stayed behind. That's the last I ever saw of him, although we corresponded for a long while."

Scenting an interesting story, the watch engineer encouraged the stranger to talk. "Back here on a visit?" he asked.

"A visit . . . Yes . . . I guess you could call it that. By the way, I suppose Williams is married?"

"Yes, and has several children. No doubt he would be delighted to see you and talk over old times. His office is—"

"That's all right. I may come back later. . . . No, I guess I won't. . . . I am glad to hear that Al is prospering, as he certainly must be. He would not be pleasurably affected, I am sure, if he were to see me in my present condition."

The stranger paused a moment, then said, "One word to you, young man, before I go." He moved around face to face with the engineer. "In front of you is one who, twenty years ago, had the same chance in life as did your superintendent, Mr. Williams. At that time there was practically no difference—even if I do say it—in our ability as engineers. But there was this vital difference in our make-up, that whereas I wanted to leave here and start out to hunt a new job, he had become tired of moving around and wanted to stick here. Today he is superintendent of this place, and I am still looking for a job. He knew when to stop roving, and I didn't. That's the difference." He paused again. "Well, I must be going. I'll move over to the next town, or the one beyond that. It would only distress Williams to see me in my present condition, so I won't bother him. Don't mention my visit. Good-bye." And the stranger was gone.

Contributed by H. G. GIBSON, *Washington, D. C.*

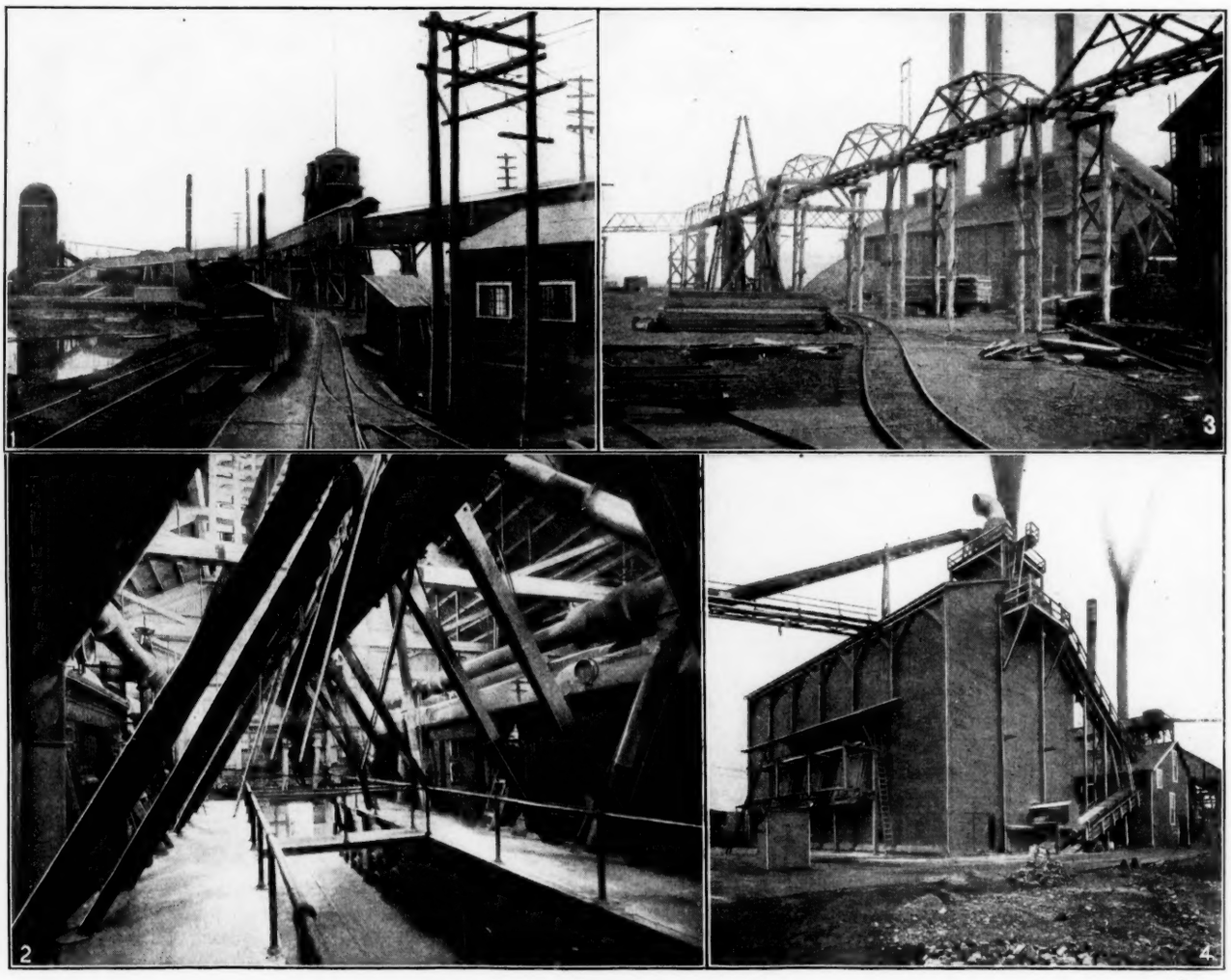
Utilization of Lumber-Mill Waste

By R. L. Watts

SYNOPSIS—It is estimated that thirty-six million cords of wood in the shape of refuse is wasted annually. Much of it is burned in boiler furnaces, and the surplus is destroyed in a burner. This article tells how one company uses all its refuse in the generation of steam for its own and other isolated steam plants.

Records show that there are over 48,000 lumber mills in the United States, and their output of waste in the form of sawdust, shavings, slabs and other wood refuse is estimated at over thirty-six million cords annually. In most plants where lumber or wooden articles are the finished products, wood is used as fuel for the boilers, because it is a refuse and can be cheaply disposed of in that manner. In many mills the amount of this refuse is much greater than can be burned under the boilers, and it is necessary to destroy the surplus in an inclosed burner equipped with a spark-arresting screen at the top. The handling of this waste to the burner and the maintenance of the latter cost the mill time and money besides being a source of inconvenience and danger. For years past this enormous waste has been going on, but the day is approaching when the sawmill burner will be of the past.

Much progress has been made in recent years in the utilization of sawmill waste. Some is used in wood-distillation plants, some in pulp mills, some is sent to local fuel markets for steam purposes, and some is used for filling in low places around the mill. No well-managed mill would produce waste if it could be avoided. This, however, is not entirely possible, so the next best thing is to seek out some method of utilizing the waste which will pay for its disposition. To this end the St. Paul & Tacoma Lumber Co., of Tacoma, Wash., one of the big mills on Puget Sound, has recently provided facilities and means for disposing of the entire output of waste at a profit. All the refuse will be used for the generation of steam—some under boilers in the company's two large steam plants, the rest in the Tacoma District Heating Co.'s plant and other isolated steam plants in the business district.



FIGS. 1 TO 4. VIEWS ABOUT THE ST. PAUL & TACOMA LUMBER CO.'S PLANT

Fig. 1—Conveying system. Fig. 2—Interior of boiler room. Fig. 3—Trestle for steam piping. Fig. 4—Fuel house, showing conveying system, truck-loading bins and blower line

The wood fuel is sold on the basis of volume, by the "unit." One unit of mill refuse in ground-up state contains 200 cu.ft.

From numerous tests carried on it was found that 50 lb. of water can be evaporated from one cubic foot of "hog" fuel. However, the value varies with the kind of wood and the moisture contained therein. There is not much information available on the subject of wood fuel, but it is the intention of the St. Paul & Tacoma Lumber Co. to conduct tests in the near future, the results of which will be published in *Power*.

The sources of the waste in this mill are sawdust and "hogged" (ground) wood from the main sawmill and shingle mill, and shavings and planer dust from the large planing mill and handle factory. From the slabs material for making laths and broom handles is taken, the better grade of the remaining slab is cut up and sold for fuel through the company's fuel department; the rest, accompanied by edgings, trimmings, etc., from the band mills, edgers, etc., passes through fuel grinders (hogs) which reduce it to a size that can be economically handled in boiler plants. The lighter material, such as shavings and planer dust, is handled by large blowers, directly connected to electric motors.

In order to have on hand a reserve supply of fuel to protect against breakdowns and for times that the mills are not running, a storage vault of 200,000 cu.ft. capacity was erected. The construction of this building is wood throughout. It is 100 ft. long, 50 ft. wide and 65 ft. to the peak of the roof. The floor is hoppered to permit of the fuel being taken out readily. All fuel is taken into the storage vault at the top and removed at the bottom through doors discharging on two 16-in. chain conveyors (Fig. 5). A 16-in. chain running through the fuel house at the top distributes the fuel evenly, discharging upon this 16-in. chain all of the planing-mill refuse from the blowpipe 30-in. collector located on the roof. The sawdust and hogged wood from the main sawmill, which is 1200 feet away, is carried to the fuel house on a 24-in. belt conveyor running at a belt speed of 250 ft. per min. This conveyor is divided into three sections and is driven by electric motors. Figs. 1 and 4 show the belt conveyors and blow lines running to the fuel house.

The fuel used by the Tacoma District Heating Co. is loaded upon specially designed hopper-bottomed cars from the conveyor at the fuel house and is switched to their boiler plant by the Northern Pacific Ry. Provision is also made to load these cars from the first section of the belt conveyor near the sawmill. On the outside wall of the fuel house are four bins, each of a capacity of one "unit," for loading the motor trucks for quick delivery to small isolated steam plants.

The conveyor which formerly carried the mill waste to the large open burner now discharges into two "hogs" (fuel grinders) capable of handling 35 cords per hour. One of these hogs is driven by a 150-hp. engine, the other by a 75-hp. motor. In a short time the burner will not be needed, and it is the intention of the management to use this space for an additional storage of fuel, which will be equipped with conveying facilities.

Thirty feet to the south of the fuel house is the new boiler plant (Fig. 2) containing eight Stirling water-tube boilers set in two rows of four each. The boilers are equipped with special wood-burning furnaces (Fig. 6) and are provided with three methods of firing—from the chain conveyor, by a blower system, and by firing slabs by hand from tramcars which can be run into the boiler room. Ordinarily, the first-named method is used, the others serving in case anything should happen to the conveying system. The boilers are not equipped with superheaters and they operate at 170 lb. gage pressure.

Steam generated in this plant is used in the company's 1200-kw. turbine generating station adjoining the boiler plant, in dry kilns, in heating and pumping. The Carsten's Packing Co. and the Puget Sound Iron and Steel Works also obtain their entire supply of steam from this plant. The packing company is 2200 ft. from the boiler plant and is connected by an 8- and a 10-in. pipe line. The amount of steam used runs as high as 800 boiler horsepower at times and is measured by a flow meter. Owing to the plants being located on tide flats, it was out of the question to consider installing the steam line under ground. Piles were driven and a trussed bridge was erected, on which the steam line is carried and which maintains an overhead clearance of 22 ft. on account of crossing over several railroad tracks (Fig. 3). How-

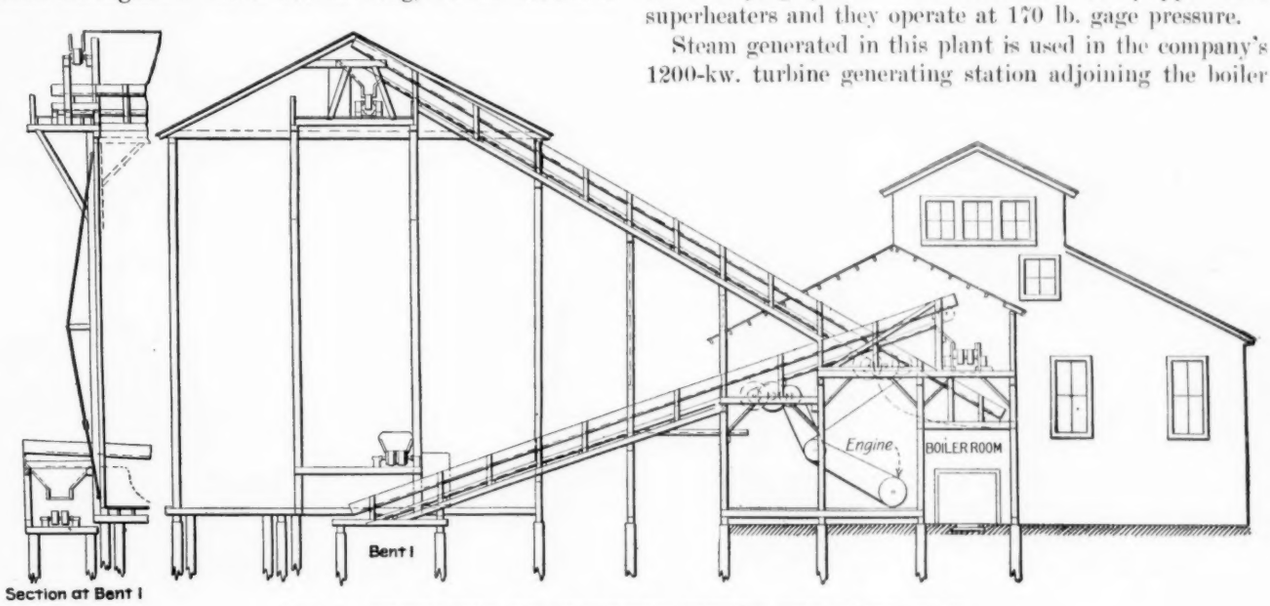


FIG. 5. ELEVATION OF CONVEYOR SYSTEM FOR WOOD FUEL

ever, the line drops in height where it is necessary to pass under elevated tracks.

The structure on which this pipe line is supported also carries two sections of the belt conveyor. Of the steam line 900 ft. is 10-in., the balance, 1200 ft., is 8-in. The pipe is all full-weight wrought iron. Each joint is flanged with extra-heavy cast-iron flanges, the flanges being recessed and the pipe peened to place. Expansion in the line is taken care of by long-sweep bends, except in the straight runs, where extra-heavy expansion joints are used, which are equipped with metallic packing. There is an 8-in. line taken off the main line, which connects the other steam plant of 2000 hp. with the new plant. At times the two plants are cut in service together, but the reason for making this connection was for emergency use.

The insulation of the steam line is something out of the ordinary and is very high in efficiency. The covering was made on the ground. A mixture of diatomaceous earth, asbestos fiber and a small amount of building plaster was molded into a sectional covering 2½ in. thick. The sections were carefully grouted, and wired to the pipe, using galvanized wire; the ends and sections were pointed up and served with four layers of tar roofing paper, which was sealed with hot tar; and as a protection from the weather, two-ply sanded roofing was sealed on and held in place with 1-in. galvanized iron bands. All flanges, separators and other fittings were treated the same as the pipe. The insulation is one of great efficiency. A test was run over quite a period, which resulted in the following: the steam measured by flow meter, 10,128,000 lb.; condensation metered, 213,000 lb. This shows a loss of 2.1 per cent. and an efficiency for the covering of 97.9 per cent.

The construction of the entire project was under the direction of R. L. Watts, mechanical superintendent, of the St. Paul & Tacoma Lumber Co.

Proper Care of Manhole Gaskets

By R. B. Dale

In these days of high cost of all supplies, many economies are being carried out in the power plant that were not carefully considered in the past. One means of saving is in the proper care in the use of manhole gaskets so that they may be removed and replaced many times without destroying their usefulness

For high-pressure boilers a braided asbestos gasket of the highest quality should be used. It should be of the correct size and shape to fit properly, and before being put in place it should be covered with a thin coating of a mixture of oil and flake graphite. The bearing surface or rim on the manhole cover should not be coated with the graphite mixture, but the bearing surface of the opening in the drum should be well coated. When the gasket is first fitted, great care should be taken to make sure that it is properly centered and in place; then the nut on the bolt should be taken up so that the cover bears evenly all around.

When the boiler is again placed in regular service, the gasket should be watched and the nut drawn up sufficiently to prevent leakage, but no more tension should be put on the bolt than is required to prevent leakage, as unnecessary pressure destroys the resiliency of the gasket and reduces its life.

When removing the manhole cover, it will be found that the gasket will readily free itself from the drum, but it will adhere to the cover. Mark the position of the cover, so that it may be returned to exactly the same position as before, and do not remove the gasket from the cover. When ready to close up the drum, coat the gasket and the rim of the opening again with oil and graphite and replace the cover as nearly as possible to its previous position.

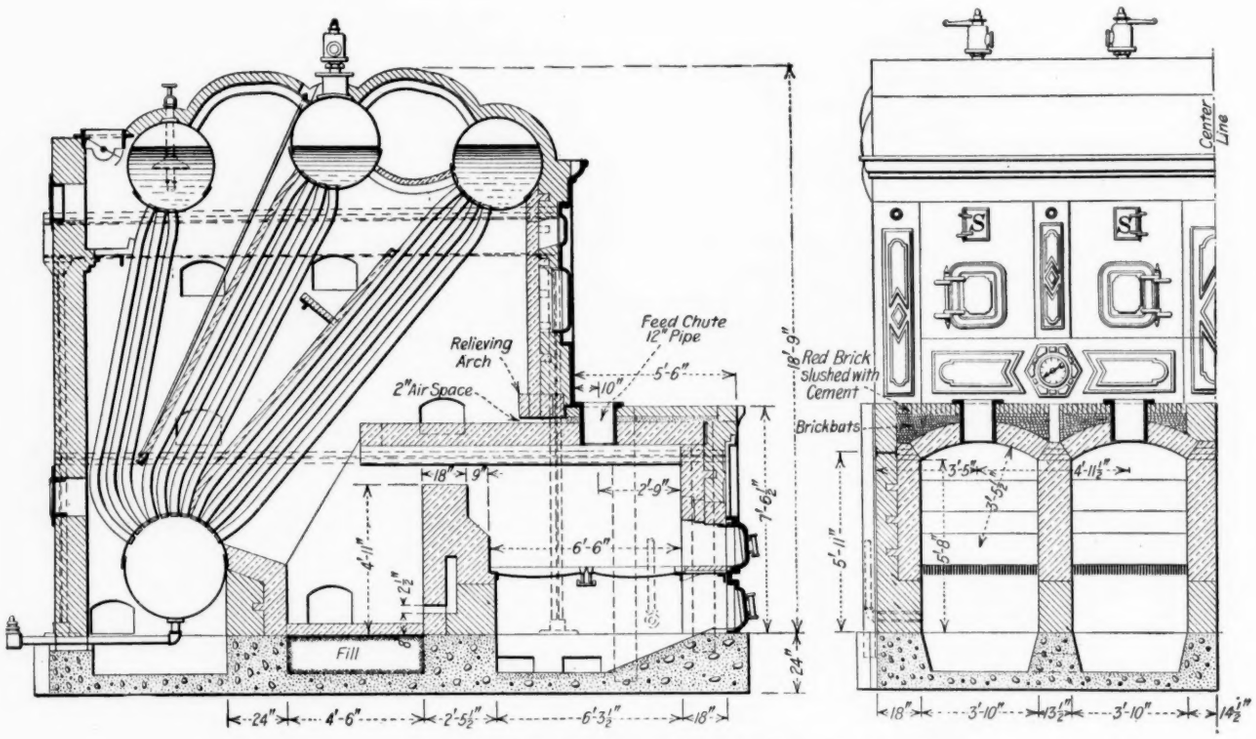


FIG. 6. DETAILS OF FURNACE FOR BURNING "HOG" FUEL

The Electrical Power Industry in China and Indo-China

By Ludwig W. Schmidt

SYNOPSIS—Detailed information is given concerning many of the power plants in China and Indo-China, also some of the standardization rules promulgated by the Engineering Society of China for the installation and operation of power plants.

According to Chinese statistics China imported electrical material during the year 1912 to the value of $1,120,192. These imports increased to $1,548,226 in 1913 and to $1,817,596 in 1914. Imports of boilers and engines in 1912 amounted to $362,802, in 1913 to $428,140, and in 1914 to $700,427. Chinese statistics are not very complete and not always specific. Nevertheless these figures give a fair estimate of the business in power machinery done with the great Eastern Asiatic republic. This business is not very large, but China has more interest for the power engineer in what she ultimately will be than in what she is now.

It is an interesting fact that possibly nowhere else in the world is there a harder struggle fought between the rival interests than in China. The battle takes place practically between German and English interests, while America is an interested yet not always a silent onlooker. While before the war there was rivalry everywhere between the big German and British electrical and power-engineering interests, it seems that only in China did they actually clash, and things in the Chinese field have been comfortably lively during the last 10 years. China has generally benefited by this competition. The country has secured a number of well-equipped power stations and has bought them in most cases for a very reasonable price. Belgian and French interests have also appeared in this market, but in real China they have been domineered by the more powerful English, German and United States firms.

France, on the other hand, has secured practically a monopoly for her own power industry in her colony, Indo-China. In this colony a Paris company, the La Compagnie des Eaux et l'Electricité de l'Indo Chine, having a capital of $1,100,000, has carried out all the leading power installations. This company is represented in Indo-China by different smaller enterprises, all dependent upon the mother company. As the managing offices are in Paris, it is quite natural that all the orders given from there will go to French concerns. Considering the small financial outlay, this particular concern has done a great deal to introduce electrical power for industrial as well as lighting purposes in this colony. It has lighted five cities—Saigon, Cholon, Pnum Penh, Hanoi and Haifong—from several modern equipped power stations, the first of which is at Choquan. This station supplies power to Saigon and Cholon. The power in this station is generated by two turbines, developing 5000 hp. Another power station of this company is situated at Mitho and two others in Hanoi and Haifong. All these stations are equipped with French machinery, some of which was built by French manufacturers but according to American patents. Besides these four larger power stations, there are a number of smaller ones, operated by private firms, either in connection with mines or industrial enterprises. These stations have found it advantageous to supply power to neighboring industries. Most of these smaller plants are using French machinery, though in a few cases English machinery is installed.

The total demand for power machinery under these circumstances cannot be very large. It was $138,968 in 1911, when in consequence of the completion of several enterprises a number of dynamos of the larger type had to be imported. Since then it has not exceeded $20,000 except in 1913. Whether it will increase again after the war is doubtful. French Indo-China is a colony of slow growth. It is possible that the experience of France during the present war may induce her to make better use of the many opportunities offered by her colony for the production of tropical and semitropical produce which may be grown there. In this case an extended demand for power can be expected. The existing larger cities, however, seem to be well supplied with light and power even if there are still several using kerosene lamps for street lighting.

A Big Field for Electrical Enterprise

To return to China proper, doubtless that country offers a big field for electrical enterprises in the future. It has become the custom to picture the Chinese merchant as a man rather disinclined to take up modern inventions, but as far as the application of electrical power is concerned, this certainly is not the case. Power engineers in China know that when they have demonstrated the advantages of electrical power, they have very little difficulty in securing contracts from the Chinese. Also the existence of a number of purely Chinese electrical enterprises proves that the Chinese merchants and financiers thoroughly realize the commercial possibilities of electrical power production in China.

Although progress has been slower than might have been expected, this was in a large measure caused by the political and economic situation of the country. It must be kept in mind that China during the last five years has suffered from a ceaseless revolutionary warfare which has been carried on in several provinces. The destruction of personal property incidental to such warfare must naturally affect the extension of public enterprises, especially that of power production. Overland lines can hardly be built in a country where military operations and guerrilla warfare are carried on. The fact, notwithstanding these many difficulties, that a great number of new power stations have been built during the last few years is possibly the best proof for the soundness of power enterprises in China.

The immediate future of electrical power development in China rests with the extension of electrical lighting in the larger cities and also with the growth of the mining industries and such industries as are incidental to mining. Furthermore, the always growing railways

have been good users of electrical energy for lighting and operating purposes.

A list contained in the Chinese Year-Book enumerates 65 cities as having power stations and lighting installations and 4 having electric tramways. This long list of electrical-power enterprises compares more than favorably with the gas-works at present in operation in China. These are located in Antung, Hongkong, Shanghai and Dairen.

The problem whether gas or electric light will predominate, whether the gas motor or the electric motor will be the future leading motive power in China, has already been solved definitely in favor of electrical energy. China has sufficient coal to make it possible for her to create a large gas industry, but the difficulties of transportation alone would finally have turned the scale in favor of the electrical power station. The question is only of interest now in so far as it refers to the use of electrical power as opposed to gas for heating and cooking purposes.

The existing gas-works have found a certain sale for gas among the leading Chinese for cooking purposes and also for industrial gas engines. While the latter can be easily replaced by electric motors, it is doubtful whether electrical cooking and heating can take the place of gas, even where electricity is first in the field. So far electrical kitchen stoves have not found much favor with the Chinese. Whether they ultimately will, depends largely upon the price for which electrical power can be supplied for cooking purposes. This question is one which agitates the minds of many of the central-station engineers in the Far East and turns up frequently during shareholder meetings. It is one of the many problems the solution of which is closely connected with the future of electrical-power development in China.

Chinese Electrical Enterprises

Street lighting as a source of power demand in the cities is making very good progress. Among the power stations completed during recent years there are a number built for city lighting. It is especially noteworthy that many of the newer developments are partly or totally Chinese enterprises, even if the engineers are foreigners. As an example, the Chefoo Electric Lighting Co. may be cited. This is a Chinese concern and was formed during 1913, with a capital of $50,000. The power of the plant is generated by two 100-kw. alternators. The manager and assistant manager are Chinese, while the engineering staff consists of Japanese. To light the city the company had to erect approximately 1000 poles. Also the Newchwang Water-Works and Electric Light Co. is a Chinese-Japanese concern.

The plant in Hangchow very soon became such a success with the local consumers that during the last year it was necessary to increase the supply facilities. The company therefore agreed to enlarge the capacity of the power station from 480 to 980 kw. The order for the machinery went to an American firm. In this way it will be possible to add 12,500 lamps to the existing installation and considerably increase the available energy for power. The same is the case in Sungkiang, where the newly erected power station after one year's operation proved to be too small for the demand, and an increase in the supply facilities became imperative. The Dairen electric light service, which is supplied by the plant of the South Manchurian Ry., requires energy for 58,126 lamps. The station in Foochow supplies 30,000 lamps. This company has a capital of $120,000 and a total gross income from the sale of electric current of $90,000 to $100,000.

The most efficient power station in the whole Asiatic East is possibly that of the Shanghai municipal electric plant. Although this station also supplies power for tramway purposes, a few of the statistics relating to its power supply and production may be given here as bearing also on the subject of energy demand for electric lighting. This station in 1915 supplied a street-lighting load of 44 arc lamps and 1422 metal lamps, and a power load of 14,547 hp. A total of 49,787,397 kw.-hr. was sold. Of this, 30,633,455 kw.-hr. was for power use and 3,395,812 kw.-hr. for traction. The station has on its staff 76 Europeans and 885 Chinese employees.

It therefore appears that the value of electrical energy for street-lighting purposes in China is established and that no difficulties will exist in the extension of sales in this direction. Also it appears that when peace has been restored throughout the republic, there will be sufficient Chinese capital available to erect new stations where they are found necessary. Of course in all these cases small beginnings will have to be made, and the business to be obtained by the importer of electrical machinery at first cannot be large.

Power Sales for Electric Tramways

The power sales for electric-tramway purposes have also made progress. This, however, is caused not so much by the installation of new tramways as by the increase in the use of older systems. A Russian company is considering installing an electric tramway in Harbin. The tramways of Shanghai doubtless are the best and are operated by several interests. The Shanghai Electric Construction Co., which has a capital of $1,557,280, operates the International Settlement Ry. This company does not produce its own power, but has an agreement with the municipal power plant. The Compagnie Francaise de Tramways et d'Eclairage Electriques also has a large power house in Shanghai. The generators and other machines used in this power house are practically all of French make. The Inland Electric Co. has two stations, one of which supplies the tramway. The machines in this station are of English and German make. The second plant, which is used for lighting purposes, has a 250-kw. direct-current generator of German make.

The difficulties in the way of tramway extension are manifold. Not only has it been hard to induce the native population to use the tramways, but also the European population has preferred the more exclusive rickshaw as a personal conveyance. The laying of the rails has likewise proved a not always easy task. The operation has been made difficult by the continual changes in the value of Chinese money, even of the smaller kind. These, with several other impediments, so far have discouraged the rapid extension of the existing tramway systems and the addition of new ones. Favorable changes, however, are sure to come.

The sale of power for industrial and mining enterprises depends entirely upon the progress of the future industrial life of China. Opinions about the possibilities of this development differ greatly The mining industry has been making good progress, and it is a recognized

fact that wherever mining is taken up power demand arises. Also, the iron industry is developing. The power stations of the Nanyan iron-works and the Pinchin collieries are among the leading plants of the country. Therefore, where there is iron or coal mining or where large iron-works can be erected, there are possibilities of electric-power development. The fact that the power station as a rule is built and operated by the industrial enterprise using most of the power is a certain disadvantage as far as private enterprise in the construction and operation of power houses is concerned. It may have a certain influence in the future with regard to the selection of the firms supplying the machines.

The leading iron-works and coal mines are in the hands either of British, British-Chinese, Chinese-Japanese, Chinese or in a few cases, German and German-Chinese concerns. None of these big enterprises is financed by American capital. Until the present war it was the tendency of these enterprises to always support their own industries. If this is continued, it will mean that American electrical-power interests will find it increasingly difficult to make sales. The Japanese also have entered the market and are selling power machinery to China. As they not only operate several of the leading enterprises of the class just mentioned, but also work several independent power stations in connection with Chinese interests, their chances to increase their imports are very good.

Industrial Growth and Concession Policy

Industrial growth in China seems to be dependent upon the so-called concession policy. If China continues her present practice of selling her industrial concessions against the granting of loans, this will very soon bring the entire power supply into the hands of certain groups able to give loans to the central government. This tendency in some cases has been counteracted by the active interest taken by some of the municipalities and the local merchants in electrical-power supply. But there is no doubt that the trend at present is in a direction not entirely satisfactory to the interests of those who want to see China a free field for power development.

The existence of many European industrial enterprises outside of the mining and iron industry has a good deal to do with the electric-power development. During recent years European firms, German and English especially, have seen that it was to their advantage to erect manufacturing plants in Chinese cities with the intention of making use of the cheap native labor. The increase of machine-made laces coming from China to this country, for instance, is an example of this activity. It is only natural that the companies will exert their influence wherever they can in favor of the installation of power plants made in their own country. It is not suggested that American interests should employ the same methods, but it is certainly necessary that they should recognize the existence of these difficulties.

The active interest which American firms have taken in the power development of China in recent years, especially since the European War began, has shown that they are already awake to the new conditions and are willing to cope with the situation as it offers itself. For instance, one leading American house only recently has taken its Chinese representation into its own hands, having been formerly represented by a foreign concern.

China has by no means been so good a market for American electrical machinery as, for instance, Japan. In 1914, the last year before the war, we sent to China proper electrical generators to the value of only $13,089, to Chinese territory leased to Japan $16,253 and to Hongkong $9949. In the same period our export of stationary and gasoline engines to China amounted to $14,318, to Japanese China $1002 and to Hongkong $3654. The demand for stationary steam engines, which had been very small in former years, suddenly increased considerably during the year 1914 and reached $136,307 for China alone. Neither of the other two markets bought any steam engines during that year.

With regard to motors and power machinery the development has only begun. This to some extent is an advantage to China, as it still will allow the building up of the electrical-power industry in such a way as to make possible a standardization. At present there are no recognized standards of electrical development in use in China. The power-plant engineers have followed mostly their own interests, and the individual firms in many cases have even intentionally used individual standards so as to compel the power stations to order any further material from the firm making the first installation. Alternating or direct current is supplied according to personal taste, and there are differences in the number of phases, frequencies and voltages. It will be, of course, impossible to remove all these difficulties in one sweep, but the first steps have been taken. The Engineering Society of China has taken up the matter in recent years and has made a number of proposals to be followed by engineers and engineering firms interested in power supply and distribution. Also these standards have been brought to the notice of foreign firms.

Electrical Standardization Rules

The propositions laid down are as follows:

1. Electrical generation and distribution systems shall be three-phase at 30 or 60 cycles per second.

2. Distribution shall be done in general by a four-wire three-phase system with grounded neutral at a pressure of 250 volts between one phase and neutral; that is, 440 volts approximately between phases.

3. The standard pressure for domestic lighting and similar supply shall be 250 volts.

4. When it is not desirable or economical to use a four-wire three-phase supply, then the three-wire system with neutral grounded or a two-wire system with one side grounded shall be adopted; in all cases the pressure to ground shall be 250 volts.

5. The use of direct-current systems shall be discouraged and shall not be allowed for systems involving either over 50-kw. capacity or having feeders over one-half mile in length.

6. No fuses or switches shall be allowed in the neutral wire.

7. Where direct-current systems are essential, the generation and distribution shall be a three-wire system, 500 volts between outside legs, with the neutral grounded.

8. The following pressures shall be considered as standards for high-tension transmission: 2200 volts, 3300 volts, 6600 volts, pressures above 6600 volts to be as required by local and other conditions.

Information about the equipment of the stations is not always easily obtained. The following short items have

been collected from various reports and from a lecture by Prof. Middleton Smith read before the University of Hongkong.

Hongkong—In one of the power houses 2000 kw. of Diesel engines and 600 kw. of steam engines are used. In another there are engines of 516 kw. The Taikoo Dockyard has its own plant having a capacity of 2250 kw. The Hongkong Whampoo Dock Co. has a plant of 500 kw. capacity.

Canton—The Canton Public Supply Co. plant has a capacity of 1540 kw., steam and Diesel engines being used.

Shanghai—The capacity of the municipal plant is 14,000 kw. and is to be increased to 20,000 kw. The machine equipment of the two other plants has already been mentioned.

Soochow—The plant has a capacity of 1375 kw. The machines are three-phase alternators driven by steam engines.

Changchow—Capacity, 150 kw. Equipment, three-phase alternators and steam engines.

Tientsin—Two 75-kw. alternators and steam engines.

Fatshan—Three 60-kw. three-phase alternators driven by oil engines.

Shahki—Two 30-kw. alternators driven by producer gas engines.

Cheungchow—One 40-kw. dynamo driven by a gas engine.

Kongmoon—One 40-kw. dynamo driven by a gas engine. Also one 75-kw. single-phase alternator.

Hoihow—One 21-kw. dynamo, driven by an oil engine.

Macao—The Electric Light Co.'s plant has four 200-kw. alternators driven by Diesel engines.

Yunnanfu—Two water-turbine sets of 300 kw. each.

Mengtsz—One 75-kw. single-phase alternator.

Sainam—One 40-kw. three-phase alternator.

Tailang—One 40-kw. three-phase alternator.

Shekloang—One 40-kw. three-phase alternator.

Nanning—One 75-kw. and one 40-kw. three-phase alternator.

Mukden—One 500-kw. turbo-alternator set.

Chungchun—One 250-kw. turbo-alternator.

Foochow—Two engine-driven sets of 150-kw. and one turbine of 500 kw.

Clrefoo—Two sets of 100-kw. steam-driven alternators.

According to a report of Consul-General Edwin S. Cunningham in Hankow, this city has four electric lighting plants. They are the Hankow Light and Power Co., which is a British plant using alternators; the Hankow Water Works and Electric Light Co., a Chinese concern; the Melchers & Co., a German concern; and the Tai Shoh Electric Co. owned by Japanese.

Since the outbreak of the war Japanese interests have been very active in China. Japan has earned money and seems to intend to invest part of it in China. The new agreement between Japan and China giving to Japan great concessional rights in South Manchuria certainly will enhance the already favorable position of Japan on the Asiatic continent.

Steam-Engine Troubles—Bearings

By H. Hamkens

SYNOPSIS—The article treats of the lubrication of crankpins and main and outboard bearings. Foundation bolts and governor pins are discussed

It is generally conceded that the crankpin of a Corliss engine, whether heavy-duty or girder-frame type, should be lubricated by means of a so-called centrifugal or center oiler. An outline of the arrangement is shown in Fig. 56. In this way the amount of oil can be regulated at all times. The use of a grease cup on the crankpin will give trouble; the engineer has no control over it as long as the engine is running and there is danger of its breaking off at the shank and hurting someone. Grease and oil together should never be used on a crankpin for if any grease gets into the oil-grooves and split of the boxes, the oil cannot spread out properly over the bearing, and very likely the pin will get hot. As soon as it gets too hot the grease will melt and run off, and at the same time its lubricating quality will be destroyed. It is better to keep grease off where oil is used.

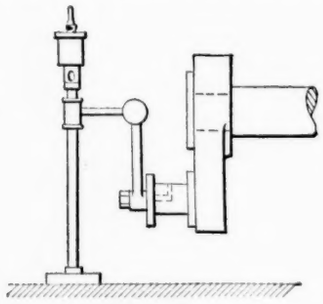


FIG. 56. CRANKPIN OILER

The oiling of the crosshead pin is best when done by a wiper (Fig. 57). This consists of a brass tube, closed at both ends and suspended from the upper part of the guide by means of two short pieces of pipe. One of the supports is threaded for an oil cup. A wiper cup of sufficient height is provided for the crosshead pin. There are a number of small holes drilled in each end of the brass tube on the upper side, so that any oil that oozes out will run over the tube and hang in drops on the under side, where the lip of the wiper cup will wipe them off and lead them to the pin. The hole in the crosshead pin must point upward, otherwise no oil will get there. The height of the wiper cup should be at least 3 in. more than half the diameter of the pin. This seems to be the most reliable oiler for the crosshead pin; everything is in plain view of the engineer and under his control.

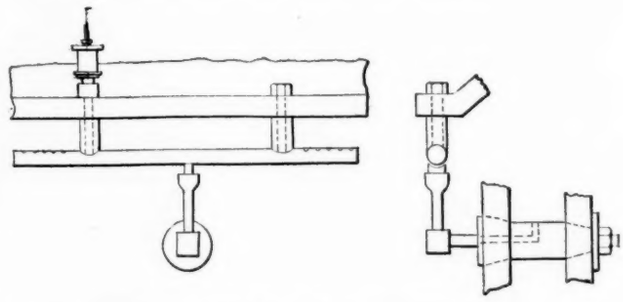


FIG. 57. OILER FOR CROSSHEAD PIN

Telescopic crosshead-pin oilers, which were in vogue a few years ago, have been a great disappointment. They cannot be relied on; there are too many parts to them,

allowing the oil to escape. Then the sliding of one tube inside of another acts like a pump—the up-and-down movement of the outer tube draws in air and forces it out again, which interferes with a steady flow of the oil. The tubes wear very rapidly in some instances and so do the joints. For a while the oilers seem to be all right, espe-

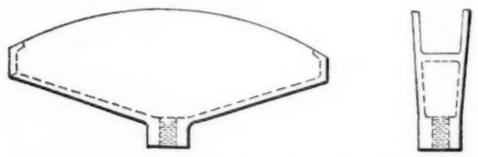


FIG. 58. OIL BOAT FOR ECCENTRIC

cially when new, but trouble will come and when it does there is enough of it to keep the engineer busy.

Telescopic oilers have also been used quite extensively on eccentrics, but after some sad experiences with them the old time oil boat has come into its own again. To make an oil boat effective it should be made very deep, so that no oil can escape or be thrown out. The sides should be very high in the middle, as shown in Fig. 58, to protect the oil from the suction of the flywheel. The oil boat shown in Fig. 59 is too shallow, the oil will run from one end to the other according to which way the eccentric tilts. Oil boats of the shallow kind are used

FIG. 59. A TOO-SHALLOW OIL BOAT

quite frequently and are likely to give more or less trouble unless a continuous stream of oil is used, in which case an efficient guard must be provided to catch the oil that is thrown off.

Sometimes grease is used to lubricate eccentrics, with good results. Two cups should be used on every eccentric to avoid trouble if one should get out of order.

If a gravity oiling system is used on an engine care must be taken to use pipe that is free from scale on

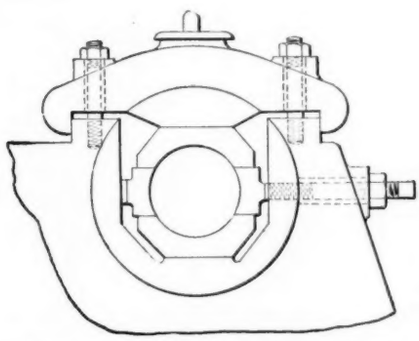


FIG. 60. COMMON MAIN BEARING
Has two quarter-boxes, an upper and lower shell, and a jaw-type cap or cover

the inside. Seamless drawn brass tubing is best for this work. All bends should be made to a long, easy radius, and there should be sufficient tees, crosses and unions, so that the pipes can be readily cleaned, if they should get clogged. Black-iron pipe or galvanized pipe will cause trouble on account of scale.

Of main-bearing designs there is a great variety, but the one using two quarter-boxes, an upper and lower shell and a cap which fits over the jaws of the pillow block, seems to be the accepted standard. Fig. 60 shows an arrangement that we find in many engines. Its disadvantage is that it has screw adjustment for the outer quarter-box only; if the opposite quarter-box wears, shims will have to be used on that side. The jaws should be made wide enough to let the bottom box be rolled out by lifting the shaft. This is a very important feature which is not carried out in some engines. If the lower box has to be removed on the eccentric side, there is usually more or less trouble.

For ordinary factories a main bearing like Fig. 60 will be satisfactory, but where the work is heavy and continuous, as in rolling mills and for large direct-connected

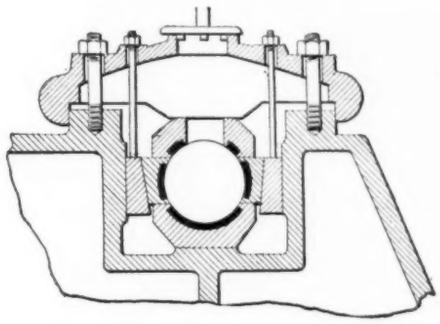


FIG. 61. MAIN BEARING ADAPTED TO ROLLING MILL AND OTHER HEAVY SERVICE

engines, the one shown in Fig. 61 will give better results. In this design both quarter-boxes are adjusted by means of wedges. The wedges should always have full bearing on the quarter-box, to prevent the latter from tilting and binding on the shaft. Many main bearings run hot and give trouble on account of the wedges being too short, as shown in Fig. 63, in which case the shaft in bearing against the upper corner will throw the lower edge of the quarter-box inward—in other words it will make the quarter-box act as a lever.

Fig. 62 illustrates a bearing that is well adapted for direct-connected engines; it has about all the refinements

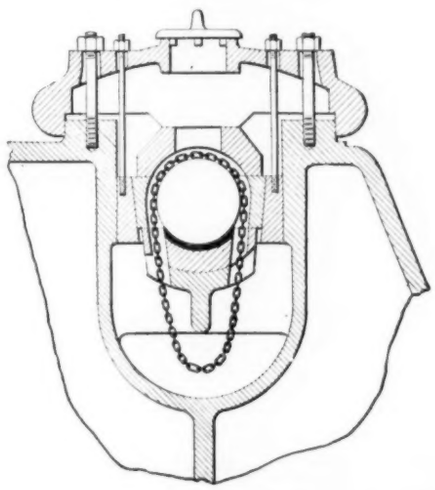


FIG. 62. MAIN BEARING FOR HIGH-SPEED ENGINES

that a main bearing needs. The quarter-boxes are taken up by wedges. The lower box is made cylindrical, and it can even be made with a spherical seat if desired. Cylindrical and spherical shells can be removed by simply

relieving them of the weight of the shaft; there is no need to take the generator apart, which must be done if a flat-bottomed lower box has to be taken out. The bearing is provided with chain oilers, which will carry a good supply from the reservoir over the shaft, assuming, of

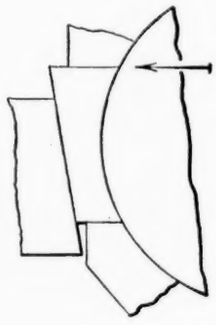


FIG. 63

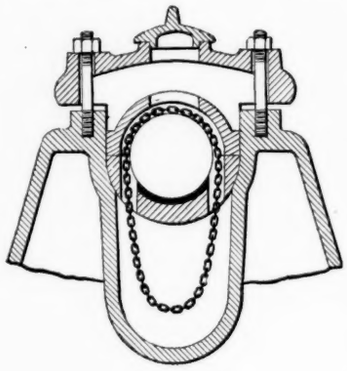


FIG. 64

Fig. 63—The wedges are too-short for the quarter box.
Fig. 64—A good type of outboard bearing

course, that the chains are running. It is not wise to depend on chain oilers entirely; if used in connection with a gravity oiling system, they are a convenience to the engineer. The oil in the reservoir must be renewed from time to time and all sediment removed. If this is neglected, a bearing may run hot in spite of the chain oilers.

If a bearing does run hot, one of the worst things that can be done is to turn water on it; water always contains more or less grit and dirt unless it is distilled, and it will spoil a bearing. If grit of any kind once gets into a bearing, it will be found hard to remove. A hot bearing should be treated with plenty of high-grade oil; cylinder oil will help some, but of course, if it gets into a bearing, it is difficult to get it out again. There is no cure for a hot bearing except to find and remove the cause.

The outer bearing often gives more trouble than the main bearing, because the shaft turns always in the same position, while in the main bearing it is moved forward and backward, owing to the push and pull of the connecting-rod. In fact, the pressures vary constantly in accord with the forces acting on the crankpin; therefore the outer bearing must be provided with ample means for lubrication and should be watched very closely on a new engine. It is best to use a construction similar to the main bearing. Quarter-boxes are not absolutely necessary, but a removable-bottom box is most desirable. Fig. 64 shows such an arrangement. It also shows a chain-oiler, which is of more use on an outer bearing than on a main bearing. The cap must be provided with a large opening, enabling the engineer to examine shaft and oiler without difficulty. A copious supply of oil is to be recommended.

Fig. 65 shows an outer bearing made in four parts. The quarter-boxes can be adjusted by means of set-screws—a convenient way, since there is hardly any side strain in this case. There are two oil shields bolted to the bearing—one on the inner and the other on the outer side, which serve the double purpose of holding the boxes in place and collecting the oil that runs off. The outer shield has a hole in the center to feel the shaft. A grooved ring is provided on the shaft inside of the inner shield; the ring is shrunk on, its function being to keep oil from creeping along the shaft. If necessary a wiper may be attached to it.

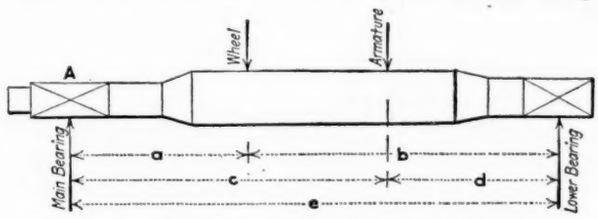


FIG. 66. DIAGRAM TO ASSIST IN CALCULATING PRESSURES ON BEARINGS

If a bearing is large enough and well lubricated it should run for years without being rebabbitted. To attain this the pressure must not exceed 100 lb. per sq.in. of projected area. Any pressure over 130 lb. per sq.in. is dangerous and liable to heat the bearing, even with a good supply of oil. On the main bearing it is not so important to take the steam pressure on the piston into account, as the weight of the crank, shaft, flywheel, armature, etc., because the dead weight of these parts is always acting in the same direction, while the pressure due to the force of the steam acts alternately in opposite directions, giving the oil a chance to work its way between quarter-boxes and shaft. The lower shells of main and outer bearing are the parts exposed to a continuous grind that will give trouble if overloaded. The old rule, to make the diameter of the crankshaft equal to one-half the diameter of the piston and its length equal to the same, gave good results for ordinary belt or rope drives, but for rolling mills, electric light and power plants and other installations where very heavy flywheels are required, this rule is deficient and the size of the bearing must be carefully considered. To determine approximately the pressures on main and outer bearings, it is well to lay down a simple diagram, as shown in Fig. 66, and to ascertain the reactions *A* and *B*. Without going into any refinements the following calculation will give a pretty good idea of the pressures one has to deal with on a single-cylinder Corliss engine.

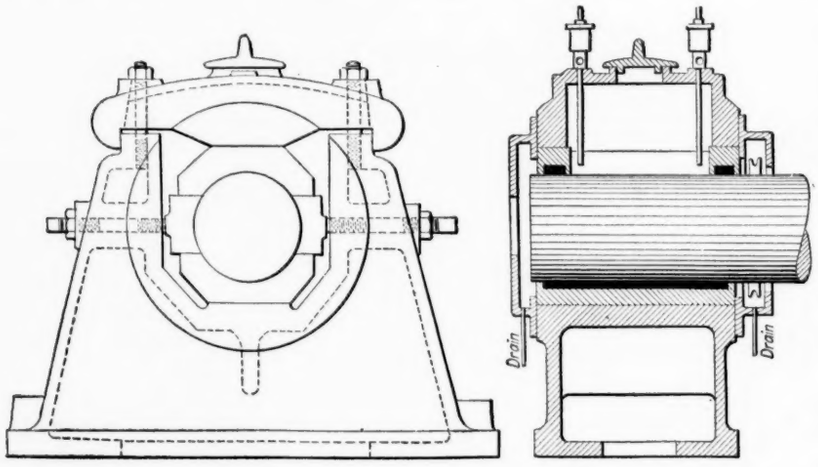


FIG. 65. AN OUTBOARD BEARING OF EXCELLENT DESIGN

Let

F = Weight of flywheel;
G = Weight of armature;
S = Weight of shaft;
C = Weight of crank;
A = Reaction of main bearing;
B = Reaction of outer bearing;

Then

$$A = \frac{F \times b}{e} + \frac{G \times d}{e} + \tfrac{1}{2}S + C$$

$$B = \frac{F \times a}{e} + \frac{G \times c}{e} + \tfrac{1}{2}S$$

The lower-case letters in the formula are taken from Fig. 66. These formulas, of course, are not quite correct, but they will answer for all practical purposes. To get the pressure per square inch A and B must be divided by the projected area of the respective bearings.

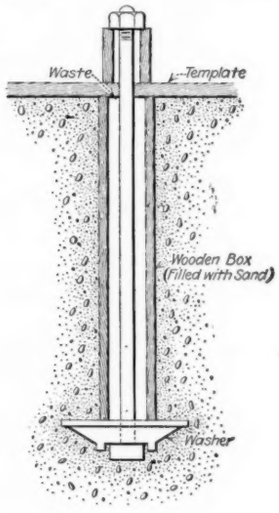


FIG. 67

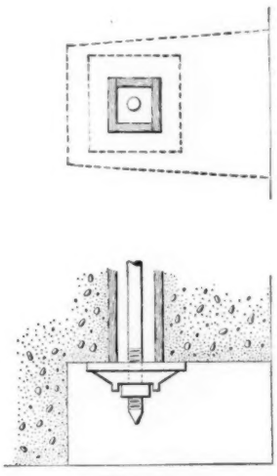


FIG. 68

In erecting an engine much trouble is sometimes experienced if the foundation bolts are cemented in solid before the engine is put in place. There is no need of having the bolts cemented in at all—in fact they should have play in the foundation, so as to accommodate themselves to the holes in the frame and cylinder base. It is well to leave about ¾ in. play all around, and for bolts 2 in. in diameter and over a play of 1 in. on the side will be better. The bolts should be long, reaching almost to the bottom of the foundation. In erecting, they are to be suspended from the templet with the cast-iron foundation washers resting on the bolt heads, as shown in Fig. 67. Next, wooden boxes of ½in. or ⅝-in. boards are built around the bolts and supported on the washers, the top of the boxes to be level with the top of the foundation. The foundation is then built of concrete, or brick laid in cement—preferably concrete. The space in the wooden boxes around the bolts should be filled with sand and some waste put on top to keep out the cement. The sand is filled in loosely so the bolt will yield to one side or the other if necessary. The boxes may be left in the foundation, where they will not do any harm.

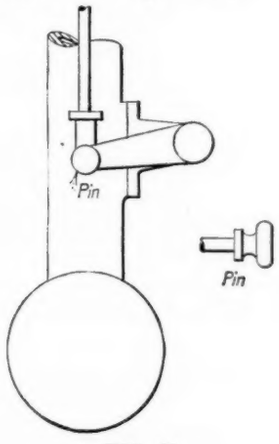


FIG. 69

Fig. 68 shows the lower end of the foundation bolt and the washer located in a pocket in the foundation. The pocket should be so arranged that it is at all times accessible. In this case the bolt has a long thread with a nut; the end is pointed so it will enter the nut freely. The idea of having these pockets is that the foundation bolts can be inserted after the heavy parts of the engine have been put in place. This is a very convenient method on large frames, where the bolts sometimes project from 2 to 4 ft. and more above the foundation; also, if one should break it can be replaced.

The space around the bolts must not be filled with cement or grouting, but, as previously stated, with sand, sawdust or some other soft material. Anything that will bind the bolt must be kept out of the hole. The only object of the foundation bolts is to hold the engine down tight, so that the friction between the base and the foundation is sufficient to keep it from moving; they should not fit in the holes and be subjected to shear.

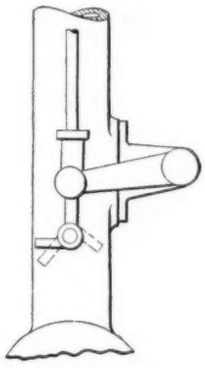


FIG. 69-A

Some accidents to Corliss engines have been caused by a small pin used on the governor, shown in Fig. 69. In starting the engine the governor is raised sufficiently to insert the pin in a hole in the governor column. With the governor in this position the engine will take steam full stroke. As the speed increases the lever will be lifted off the pin and the engine will begin to cut off. That is the time the pin should be taken out of the hole, but some engineers leave it in, and if anything should happen to the governor belt or gears to stop the governor, the lever will drop down on the pin, the engine take steam full stroke and will probably run away, since the pin prevents the governor from throwing in the safety cams. If instead of the pin a little lever is substituted, as shown in Fig. 69-A, it will automatically drop into the position shown in dotted lines as soon as the governor rises, and the danger will be avoided.

A still more antiquated design than the little pin is shown in Fig. 70. It consists of a collar located on the governor column, having a slot into which the governor sleeve may drop provided it is in the right position. If the slot is not in the right place the governor cannot drop sufficiently to make the safety cams operative. Wherever that ominous little pin or the collar is still in use on an engine, the engineer and proprietor had better be cautious. No insurance company will tolerate either one of these contrivances. Some engine builders are using the collar with a spring inside to throw it automatically into the proper position as soon as the governor rises. This, of course, eliminates the danger if everything is in good working order.

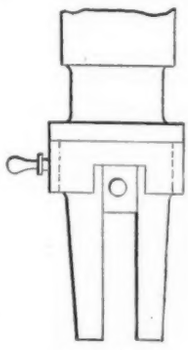


FIG. 70

[*Hook rods and connecting-rods will be discussed in the next article.*]

A Central Station Viewpoint of an Isolated Power Plant

By Julius G. Berger

SYNOPSIS—A general discussion on how the the central station analyzes the cost of producing power in an industrial power plant and its argument in favor of purchased power.

Perhaps one of the most recent segregations in manufacturing is the production of electric power in a central plant and distributing it by transmission lines to the doors of the manufacturer, where it is sold to him in proportion to his needs. Why does the sale of central-station power continue to exist and grow? Because many find it cheaper and more reliable than their own smaller power plants.

It is for this reason that central stations wish to analyze private plants in order to see if it will or will not pay the manufacturer to buy the power. If it will pay, it is to the advantage of both the manufacturer and the central station to have purchased power in that particular factory; if not, they had better both know it and cease wasting each other's time by further discussion. Usually, an analysis involving a test is the only way to get at the facts, for each case must be judged on its own merits.

Why do manufacturers give permission to have tests and investigations made? Because in manufacturing, as in life, it is the survival of the fittest, and each manufacturer reaches out in all directions to learn if it is not possible by changes in some of these directions to save in the cost of production. Along comes the industrial-power engineer of the central station, saying to the manufacturer: "We're in business to sell power to you if it will save you money. We'll make a complete, unbiased investigation and test of your power plant, without obligation on your part, to learn if you can cut your power costs or increase your production with the same power costs by using our power." The manufacturer begins to think: "Why, here's an opportunity to beat my competitor by lower manufacturing cost if that central station can show me a saving." So he usually allows them to make their tests and recommendations. If the investigation shows greater operating cost to the manufacturer with purchased power, the central-station engineer does not wish to sell it, since a dissatisfied user is far worse than none at all. Increased production at the same or even higher power costs will generally more than make up for the investment of changing over.

Factors Determining the Purchase of Power

This line of reasoning seems to indicate that a power engineer should test every manufacturing establishment in his territory. It is not so. He develops with time such judgment that after a very cursory survey he can tell whether it is worth while to make even preliminary estimates. For example, a 1000-hp. boiler plant running full blast and a 250-hp. steam engine would immediately indicate large requirements of live steam for industrial purposes. Consequently there is not a very good chance of eliminating much labor with purchased power. But again, the physical conditions of the plant might make purchased power a good proposition, for with it an otherwise large investment of replacing a worn engine could be reduced to the small cost of a few new motors. Again, a plant where little or no steam is used for industrial purposes or a factory where much overtime is required in a department or two would loom up to the power man as a place that could save considerable with purchased power. And there are many other conditions and combinations which at a glance put a factory in one of three classes: First, one that will be benefited materially; second, one benefited a little; third, one not benefited at all by central-station power.

If it is now concluded that purchased power would be of benefit, the engineer obtains from the manufacturer's books such data as yearly costs for coal, water, oil and waste, attendance, repairs, value of space taken up by the engine room, fixed charges such as depreciation, interest, insurance and taxes on the original investment and such of the overhead expense as is charged to the power plant. Against this is the cost of purchased power based on an assumed load factor and the rates of the central station which would supply the power, to which are added repairs, oil and waste, attendance and fixed charges, chargeable to the motors, and to the book value of the power-plant apparatus at the time it is put out of use, less its sale value. These figures are now compared, and if they show that purchased power will pay and the manufacturer wishes accurate information, a test is decided upon.

Obtaining Accurate Load Data

If there is no question of a saving with purchased power, indicating the engine is all that is necessary in order to obtain accurate load data. These would be used for estimating the kilowatt-hours that will be consumed and facilitating laying out the sizes of motors necessary throughout the plant. By cutting off departments one by one at various times, motor sizes required in these departments can be accurately determined by differences in the engine horsepower with the department on and off. In like manner friction losses may be ascertained. Should the decision rest on a closer margin, it is advisable to meter or weigh the boiler-feed water and coal and meter the steam required for industrial purposes. Take all electrical measurements if there are any, test the steam with a calorimeter, sample and analyze the flue gases periodically and measure the draft above and below the fire, all in addition to indicating the engines. In fact, a complete power-plant test is recommended. If turbines instead of engines supply the power, a measurement of steam flow and electrical readings replace indicating the engine. With all these data properly tabulated, backed by judgment and a knowledge of the manufacturing conditions at the particular factory, an intelligent recommendation can be made.

A tabulation as here shown is typical of the manner in which the facts are presented to the manufacturer:

PRESENT OPERATING COSTS, YEARLY BASIS		COSTS WITH PURCHASED POWER, YEARLY BASIS	
A = Coal	$.....	M = Purchased power at central-station rate	$.....
B = Engine oil	.....	N = Oil for motors	.....
C = Cylinder oil	.....	O = Coal for heating and industrial purposes	.....
D = Waste	.....	P = Wages for one or more firemen	.....
E = Wages for one or more engineers	.....	Q = Part of one man's time to periodically oil and inspect motors	.....
F = Wages for several firemen	.....	R = Motor repairs	.....
G = Engine repairs	.....	S = Fixed charges, consisting of depreciation, interest, taxes and insurance on the new investment, plus interest and a reasonable percentage of the book value less sale value of such power-plant apparatus as is discarded, in order that this capital account, which represents no physical asset, will eventually be wiped out	.....
H = Boiler repairs	.....		
I = Other repairs	.....		
J = Fixed charges, consisting of depreciation, interest, taxes and insurance on original investment	.....	T = Overhead	.....
K = Overhead	.....		
L = Miscellaneous expenses if any	.....		
Total	$.....	Total	$.....

The less expensive method of operation depends on the size of O and P as compared with A and F, also on the percentage S is of J. And of course the size of $A - O$ (the coal chargeable to power) depends on the amount of power lost in transmission, the condition of the engine, whether the isolated plant has electric or mechanical transmission of power, the kind of firing used under the boilers and the condition of the boilers, and in general on the ability of the stationary engineer in charge. If with purchased power much friction is eliminated by using proper motors, M becomes quite small. These and minor reasons swing the cost balance to one side or the other. Of course where purchased power is cheaper and the saving will pay for the change in a reasonable time, say three to six years, without further question it is desirable to buy the power.

Occasionally it happens that in some factories it is more costly to purchase power than to make it, and there is apparently no good reason to buy; the central station then states the facts of the case. Such plants, however, find auxiliary or breakdown power from the central station an asset worth having. In some instances other reasons than mere cost make purchased power advantageous; for example, engine and boilers nearly worn out and about to be replaced. If the manufacturer is short of capital, a small investment in motors even with somewhat higher operating costs will be the best means of saving as much money as possible for manufacturing, where it will net, say 10 to 20 per cent. instead of being invested in power-plant equipment with a nominal return figured at 6 per cent.

The more constant speed obtainable and the more reliable source of power, from duplicate and reserve equipment, which an isolated plant usually does not contain, often make the increase in production with purchased power enough to more than offset the enhanced power costs. Reasons of convenience, safety and simplicity, such as the following, often cause manufacturers to buy power even at increased cost: Enlarged power capacity can be obtained at short notice and without equipment expense aside from the cost of the motor or motors required; new machinery can be placed at the desired location far away from existing shafts; alternating-current motor repairs are usually nothing more than a new bearing lining once in three to five years; and finally there is freedom from fire risk with motor drive and no generating station.

Now, when the manufacturer has decided to use purchased power, comes the equipping of the shop with motors. In rare instances a single motor to replace the engine will serve the purpose. Usually where mechanical drive has been used, individual drives for some of the machines or groups of much or little used machines from one motor will produce considerable saving in the friction load. However, where motors are already installed, they are usually direct-current and may have to be replaced with alternating-current machines. In some instances motor-generator sets or rotary converters are used to change the alternating-current supply to direct current; then the old motors can be retained.

Many difficulties are encountered in equipping a manufacturing plant with motors, and it is seldom that two factories can be treated alike. In general one can say it is well to group much-used machines on one motor, thereby obtaining the advantage of the higher efficiency of a larger motor as well as greater overload capacity. Secondly, grouping little-used machines on one motor, provided all are used at the same time, enables much saving in power because they are shut down the major part of the time. Thirdly, it is advisable to employ individual motors on large machines whether used much or little. The ordinary run of factory groups can be driven with from 10- to 300-hp. motors and individual machines with perhaps 100 hp. as a maximum. This does not apply to steel mills, ore-handling plants or wire and tube mills, where the power requirements are usually larger.

In some old factories the motor cannot be located far enough from the driven pulley to obtain a satisfactory belt drive. This difficulty is usually overcome with a silent-chain drive. In another place the driven shaft must run at such a low speed that a jackshaft must be installed, or again, silent-chain drive might be used without a jackshaft. And then there are minor difficulties such as proper support for the motors, and location where there is reasonable circulation of air in order to prevent undue heating.

Having solved the difficulties and installed central-station power, what becomes of the stationary engineer? If the limit of his ambition has been merely to keep the power plant turning over, there is nothing left for him to do but to find employment in some plant that does not buy power. However, if he has taken a real interest in his employer's establishment and has shown his ability to improve drives and machinery in the factory, he may be retained as master mechanic or assistant in line for promotion, dependent on his ability like every other individual in the plant.

Such is the trend of thought the manufacturer and central station go through, which has led to the adoption of purchased power in many factories formerly making their own.

Roller Bearings—The use of roller bearings may be considered as representing an excellent compromise between the rugged oil bearing and the highly efficient ball bearing. It is a question whether the high-grade roller bearing of today does not exceed in dependability the more generally used oil type; as witnessed by the extremely severe usage to which they are subjected in trucks and automobiles. Careful inspection of motors equipped with roller or ball bearings that have been in use for three years revealed no indication of grease in the winding and slight apparent wear of the bearings, while it was found that oil-lubricated motors showed a great deal of oil-soaked dust in the winding, without any direct oil throwing being apparent. The use of roller bearings will increase the cost of the motors about 4 per cent.

Perpetual-Motion Analyses

SYNOPSIS—The best three exposures of two so-called perpetual motion devices are given, incidentally showing the basic error of any such attempts. At best, action and reaction can only be equal and friction must stop the machine.

In reply to our offer, in the issue of Nov. 28, page 757, of a cash prize for the best exposure of the fallacy of two so-called perpetual-motion contrivances, we have received 61 communications. The Ulram proposition received attention from only a few, and the best of these was that sent by Paul Hoffman. He is therefore declared the winner of that $5 prize in addition to the usual honorarium. His discussion of both the Ulram and Bissell proposition is given in full, his analysis of the latter being one of the best received, although Otto M. Foernsler's succinct pointing out of the fallacy without mathematical demonstration appears to be entitled to the $5 prize, plus the honorarium.

Others who had the correct conception of the fallacy of the flotation idea are: H. H. Ferris, Cheyenne, Wyo.; John Cutler, Pekin, Ill.; Eugene R. Wheatley, University, Va.; Harry D. Everett, Washington, D. C.; Harold I. Kimmey, Syracuse, N. Y.; Julian C. Smallwood, Baltimore, Md.; C. H. Watson, Bath, Me.; Ralph E. Root, Annapolis, Md.; P. B. Sample, Huntington, W. Va.; A. T. Kasley, Swissvale, Penn.; B. D. Wells, Cambridge, Mass.; James W. Blackwell, Jr., Pittsfield, Mass.; A. E. Knowlton, Hartford, Conn.; H. R. Cady, Philadelphia, Penn.; John Hagg, Philadelphia, Penn.; and John J. Ramsey, Attica, Kan.

The Ulram Proposition

It is not quite clear how the different working parts are connected, but this much seems clear: That the ¾ cylinder called C and the two movable weights A and B form a system of masses supposed to be in balance in the starting position, reproduced here in Fig. 1.

According to the accepted definition, a body is said to be in balance when its center of gravity coincides with its axis of rotation or oscillation. Applied to the present case, this means that the common center of gravity of A, B and C must fall into the axis through M, the center line of the cylinder.

The position of C_1, center of gravity of the ¾ cylinder, is easily obtainable through subtraction of ¼ from the whole circle; likewise C_2 can be located without difficulty through combination of the centers of gravity a and b, of the weights A and B. The resulting center of gravity of A, B and C will be situated on the connecting line C_1C_2, and in order to have a balanced condition, this line must pass through M and must be divided by M in the inverse ratio of the weights:

$$\frac{C_2M}{C_1M} = \frac{C}{A+B}$$

or

$$\frac{C_2M + C_1M}{C_1M} = \frac{A+B+C}{A+B}$$

$$\frac{C_1C_2}{C_1M} = \frac{A+B+C}{A+B} \qquad (1)$$

If now the weight B is made to drop into the dotted position, its center of gravity moves into b^1, vertically

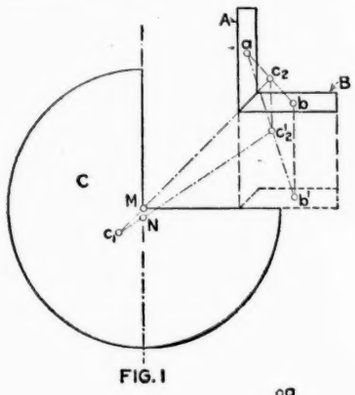


FIG. 1

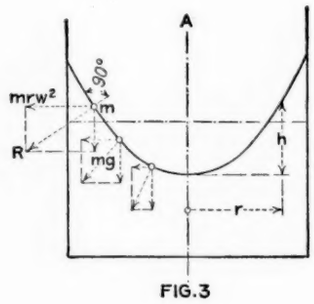


FIG. 3

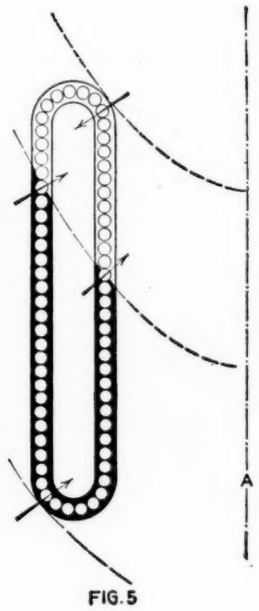


FIG. 5

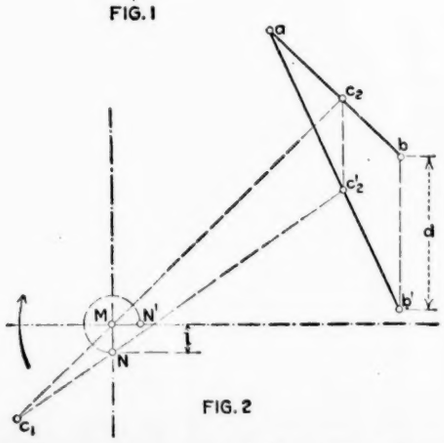


FIG. 2

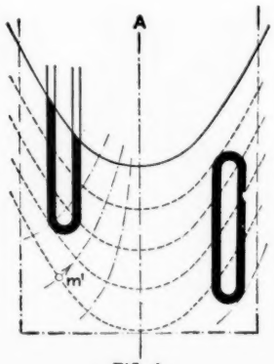


FIG. 4

FIGS. 1 TO 5. AN ANALYSIS OF THE FORCES INVOLVED IN TWO ATTEMPTS AT PERPETUAL MOTION

Figs. 1 and 2—The Ulram device. Figs. 3 to 5—The Bissell machine

under b, and the combined center of gravity C_2 of A and B, will equally move vertically downward into C^1_2 (Fig. 1). The new center of gravity of the whole system will be obtained, as before, by joining C_1 to C^1_2 and dividing $C_1C^1_2$ in the same proportion as C_1C_2. This locates the new common center of gravity vertically under M in a position N, so that

$$\frac{C_1C^1_2}{C_1N} = \frac{C_1C_2}{C_1M}$$

We can also write the proportion

$$\frac{C_2C^1_2}{MN} = \frac{C_1C_2}{C_1M}$$

and using equation 1,

$$\frac{C_2C^1_2}{MN} = \frac{A+B+C}{A+B}$$

wherefrom

$$MN = \frac{A+B}{A+B+C}C_2C^1_2 = \frac{A+B}{A+B+C}\frac{d}{2} \qquad (2)$$

if d designates the drop of the weight B. Here we touch the fallacy in Mr. Ulram's claim expressed in the sentence at the bottom of column 1, page 732, reading:

"The cylinder is still in balance" (after the dropping of B and incidental performing of work), "as we have not moved the weight out of its position relative to the center of the mass. If the cylinder is in balance, it will take very little power to turn it on its axis at the start," etc. This, according to our deduction, is indeed wrong, and must be corrected to read:

The cylinder is still in equilibrium (after the dropping of B), since the new center of gravity is vertically under the axis of rotation; but it is no more in balance. The change of position of B did change the distribution of the masses relative to the axis (although—and this is the misleading circumstance—the torsional momentum of B with respect to the axis through M has remained the same). Consequently, turning the cylinder on its axis will mean raising the center of gravity, or all the weights concentrated there, and will require work. Just how much work is necessary will be shown. Referring to Fig. 2, we can see, at a larger scale, what will happen if the cylinder be turned into the position assumed by the inventor (Fig. 3, page 732). This change means ¾ of a revolution, and the center of gravity N will therefore move on a circle around M, from N to N^1; in other words, the total weight will have to be lifted, during the two first quarters, to the summit of the circle with MN, will drop hereupon in the third quarter, the final difference between initial and terminal position being

$$l = NM = \frac{A+B}{A+B+C}\frac{d}{2}$$

as per equation 2. To express the work (L) performed during this operation, we have to multiply weight times lift, and find:

$$L = (A+B+C) \times \frac{A+B+C}{A+B}\frac{d}{2}$$

$$L = (A+B)\frac{d}{2}$$

or if $A = B$, as must be assumed for symmetry:

$$L = B \times d \qquad (3)$$

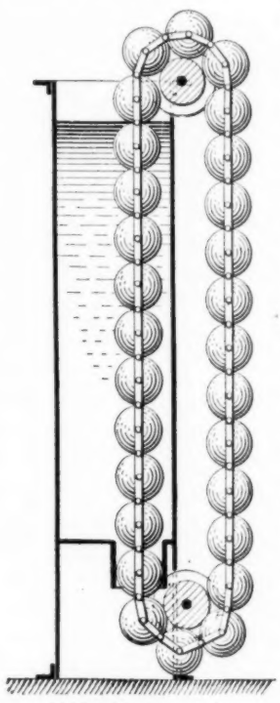
But this, "much to our surprise," is exactly the amount of energy released through the dropping of weight B (weight times drop), which therefore simply means that all the energy produced by the falling of the weight B must be consumed again, to turn the cylinder into the position illustrated (Fig. 3, page 732). Here, weight A would be ready to renew the whole operation under exactly analogous conditions, and the cycle would repeat itself endlessly, with simply an exchange of work between the constituents of the oscillating system. The preceding leaves out of consideration all friction, which will of course resist the movement, therefore additional power will actually have to be introduced into the apparatus.

The foregoing consideration is independent of the nature of the weights A and B, whether solid or filled with shot or mercury. All that is required, is that the initial and the final condition of the oscillating movement be exactly symmetrical as regards the position of the weights and the distribution of their masses. Whatever changes these may undergo in the intervening phases does not affect the amount of work to be performed, which is determined alone by the position of the common center of gravity at the beginning and at the end of the oscillation.

Phillipsburg, N. J. PAUL HOFFMAN.

THE BISSELL PROPOSITION

The inventor tries to "throw us off the scent" by spinning his device at 2000 r.p.m.. Suppose, instead, we take an ordinary column of water in a standpipe and mount hollow floats on an endless chain running over two sheaves, one placed just above the top rim of the standpipe and the other just below the bottom rim, as shown in the illustration. Then we can have the floats enter the bottom of the standpipe through a tube just long enough to reach from one float on the chain to the next. Once inside the water column, the buoyancy of the floats will cause them to pull up on the chain and they will do work in rising to the surface of the water. On going over the upper edge, their weight in descending will do work—just enough, in fact, to overcome the action of gravity on the floats which are going up, so that all the buoyancy work will be pure gain. When the floats get to the bottom of the standpipe, they must be pushed in again—but there's the rub! To push them in water must be displaced and that water under a pressure due to the total head in the standpipe. If a float occupies a cubic foot and if the standpipe is 10 ft. high, pushing the cubic foot in will require overcoming a force of 144 × 0.434 × 10 through a distance of one foot (supposing the float to have a cross-section of 1 sq.ft. and a length of 1 ft.); that is, work equivalent to 625 ft.-lb. Once in, the float has, it is true, a buoyancy of 62.5 lb., and in rising 10 ft. will do 625 ft.-lb. of work—exactly as much as was required in forcing it into the standpipe, so nothing is gained.



HOLLOW FLOAT ANALOGY

Lest there be any confusion in applying this analogy, I would point out that the figure is not correct in showing the mercury column ending at the same distance from the center of rotation, at both the top and the bottom. As a matter of fact, the lower end would necessarily come in nearer to the axis of rotation in order to be able to support the vertical column. The inner and lower end of the mercury column would be a free surface under no pressure except that of the atmosphere, but upon entering this surface, the pressure would be found to increase rapidly, until upon reaching the outer radius the pressure per square inch would be equal to that produced by the vertical column. In pushing the floats in, therefore, the whole amount of work would not be done when they were first submerged, but more work would be done as they were pushed out to regions of still greater pressure, until they reached the point farthest from the center of rotation, after which they would return work in rising through the vertical column, just as the inventor claims, and the net loss would be friction.

Brooklyn, N. Y. OTTO M. FOERNSLER.

THE FLOTATION MOTIVE

As regards this proposition, let us point out at once the fundamental error on which the inventor's claim is based. He states that when rotating the apparatus at a high speed, the mercury will stand perpendicular in the outer leg of the U-tube, the inner leg being completely empty; that the buoyancy of all the balls contained in the outer leg V in addition to the weight of the balls in the inner, empty leg, becomes available for useful work.

To demonstrate the fallacy of this contention, it will be sufficient to recall to mind the theorem of the revolving vessel containing a liquid. Referring to Fig. 3, it will be seen that the surface of the liquid, when subjected to rotation, assumes the shape of a paraboloid of rotation the axis of which coincides with the axis of rotation of the system. The higher the speed the higher the liquid will "climb" up the walls of the vessels, the formulas for the vertical elevation of any point above the center showing that it varies with the squares of the speed, namely:

$$h = \frac{r^2}{2g} w^2$$

where g = acceleration of gravity and W = angular velocity. For a given speed a condition of equilibrium establishes itself, each element of the liquid being held in a definite position by centrifugal force and gravity.

In Fig. 3 the diagram of forces is drawn for several elements of the surface; the vertical force is the weight, or mg, if m is the mass of the element, the horizontal force is the centrifugal force or mrw^2. The resultant of these two forces is always perpendicular to the parabola, which is the necessary condition of equilibrium, for then movement cannot take place along the parabola. The vertical component on all the diagrams is constant, all elements of a homogeneous liquid having uniform mass.

Acting on an element immersed in the interior of the liquid body, say at a depth h, there is a hydrostatic pressure equal to the liquid column h, which pressure acts uniformly from all sides; besides, there is the weight of the element and the centrifugal force, as already dealt with, both of which forces can again be composed to the same resultant. All points of equal hydrostatic pressure h are located on a paraboloid parallel to the surface paraboloid, at a distance h. All conditions on this paraboloid are the same as the surface except for the hydrostatic pressure; no movement of the elements, in particular, will be induced by the acting forces. Varying h, we can obtain any number of such paraboloids and find, therefore, that the body of the liquid is made up, so to speak, of parallel layers of paraboloidic shape, each one representing a surface of equal hydrostatic pressure, or a so-called equipotential surface. The internal condition of the liquid has entirely changed from the condition at rest (where the equipotential surfaces are represented by parallel horizontal planes).

Since the specific gravity of the liquid does not enter into the formula for h, the same paraboloid will obtain, at a given speed, whatever the nature of the liquid.

If an element of less specific weight m^1, Fig. 4, is introduced into the liquid at some point, it will tend to rise, as it would in the liquid at rest. But now, its buoyancy is not the difference of weight between displaced liquid and solid mass, but it is the difference of the combined weights and centrifugal forces. We have seen that the resultants of these forces are directed perpendicularly to the parabola through the considered point; the lighter element will therefore move in this direction, describing, as it rises, a curve which intersects all the succeeding parabolas at right angle, as indicated in Fig. 4. All elements will, of course, have the same vertical component of buoyancy, this being the difference of weight between liquid and solid element.

Suppose, now, that a certain portion of the liquid body be cut out, or separated from its surroundings, by a very thin solid wall, the elements thus isolated being still subject to exactly the same forces; the isolation will not change conditions from the group. And, coming to our concrete case, if this isolated portion of liquid be inclosed by a U-tube, the level in its two legs will assume such a position as is determined by a parabola of rotation, as stated and shown in Fig. 4. Points of corresponding hydrostatic pressure are located on parabolas parallel to the one determining the level in the legs; the point of highest hydrostatic pressure is where one of these parabolas is tangent to the bottom of the U-tube.

If, on the other hand, the two legs were immersed completely in the liquid, to begin with there would be no apparent change in the condition of the liquid when rotated, but there would be in its internal constitution, the equipotential paraboloidic surfaces establishing themselves throughout the liquid mass. The point of maximum and minimum hydrostatic pressure would be determined by the two tangent-parabolas at the bottom and top of the tube. Since the mass of liquid in both legs is in equilibrium, just as was the mass of the whole rotating body from which it was abstracted, no movement whatever will take place and, in particular, no continuous circulation from one leg to the other and back is possible.

This case can be applied directly to the U-tube closed on top and filled with balls, leaving no intervals between them (Fig. 5). This combination would behave exactly like a liquid, answering the definition of such as regards movability and contact of its elements.

The combination, in the invention under investigation, of mercury and balls is merely a superposition of the two cases considered. Each "liquid" being in equilibrium when considered separately, there is no reason at all why

they should not be so when combined. But it is easy to prove directly, by considering the effects of buoyancy on the balls, that no movement of these balls will be induced.

Beginning with the ball of the highest potential, at the bottom of the tube, where it is tangent to a certain parabola, its buoyancy is directed perpendicularly to the curvature of the tube, and this ball has therefore no tendency at all to move. From this bottom ball on, the balls can be grouped in pairs alternately to the right and left, so that the two balls of a pair are always on the same parabola, each furnishing the same vertical component of buoyancy and each neutralizing the other; and this procedure can be repeated until the mercury level is reached. The sum total of all the vertical components of buoyancy on each side is exactly the same, therefore there is no reason for a movement in either leg.

From the mercury level to the top—that is, to the point of tangency with the minimum-potential-parabola—the same grouping of balls in pairs of equal potential can be made, the only difference being that in place of the buoyancy the whole weight of each ball combined with its centrifugal force, the resultant acting in the opposite direction of the buoyancy, has to be introduced. Here also one ball on the right and one on the left will always neutralize each other, until the top ball is reached.

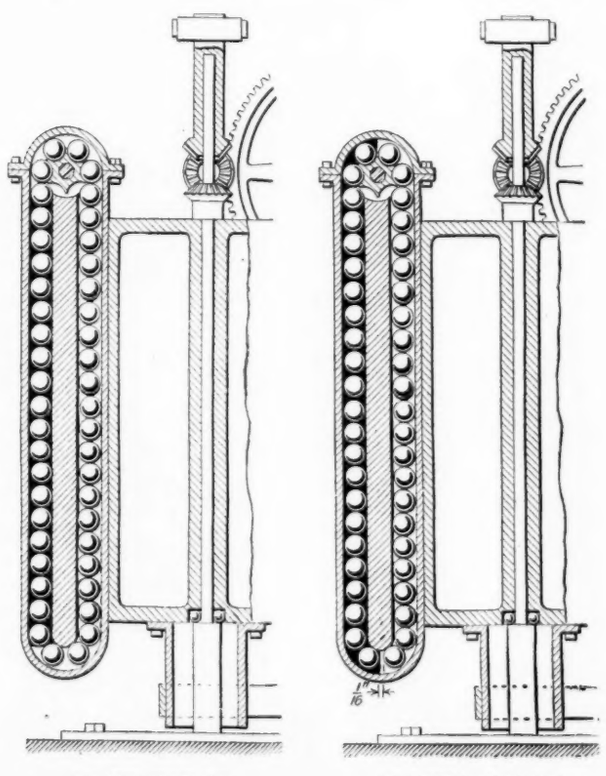
A state of perfect equilibrium prevails therefore in the entire system of balls, during rotation as well as at rest. No energy can be derived from the circulation of the balls, because there is no such circulation. On the contrary, energy must be supplied to overcome friction losses.

Phillipsburg, N. J. PAUL HOFFMAN.

The following letter has been received from J. E. Bissell, inventor of the flotation device: While reading your description of my perpetual motion I find that you have changed the appearance of the sketch enough to make the machine inoperative. You show the mercury standing up without any support at all (which is altogether impossible). I have inked in both at the top and at the bottom of the outer leg the way the mercury will stand—at the bottom a slice across the front only $\frac{1}{16}$ of an inch thick will keep the whole column standing vertical. Now, if it is objected the high centrifugal pressure will paralyze the balls and make them stand glued fast to the runway—then extend the bottom part of the whole leg out, say $\frac{1}{8}$ in. further than the top, so the centrifugal pressure will tend to force the inside balls down and out, and because the outside balls are forced in by the mercury and also buoyed up they would also tend to overcome this "wise" objection. I know any "theoretical parrot" can prove for such reasons it won't work, but I assure you four or five of the chief engineers in the different big works around here are interested enough to do more than smile. They are studying the matter with a view of undertaking experiments at this writing.

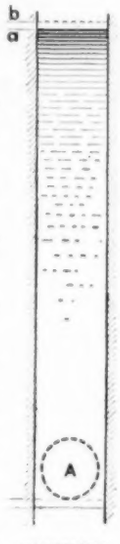
Hoping you will think the machine interesting enough to reprint a correct cut, and thanking you very much indeed for your kind interest already shown.

Pittsburgh, Penn. JOSEPH E. BISSELL.



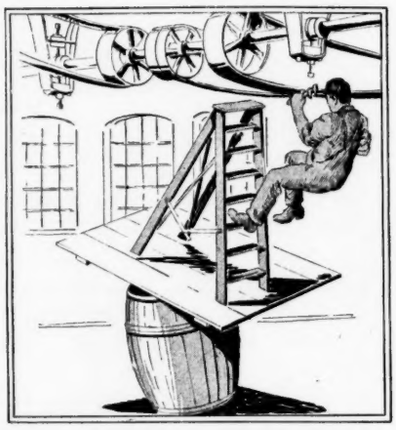
AS WE HAD IT AS HE WANTS IT

Our own explanation of the fallacy of the flotation idea (which had been the basis of many perpetual-motion schemes before Mr. Bissell discovered it) would be as follows: A column of water is held up—it does not matter whether by centrifugal force or what other artifice—as shown in the illustration, so that access may be had to its foot. If a ball were pushed through the bottom of the column as shown at *A*, it would raise the level at the top (providing the foot remained stationary), would in effect transfer a block of water equal to its own volume from the bottom to the top of the column. To do this an amount of energy equivalent to the product of the weight of the water and the height of the column must be exerted: E = Wt. of vol. of water equal to vol. of ball $\times$ height of col. The force exerted by the water to raise the weight is that exerted by the weight of a volume of water equal to that of the ball, and the energy generated by that lifting is the product of this force and the distance through which it is exerted, such distance being the height of the column, Hence, again: E = Wt. of vol. of water equal to vol. of ball $\times$ height of col. The energy furnished by the water in floating the ball from the bottom to the top of the column is equal only to the energy required to introduce the ball into the column in a position to be floated. The full buoyant force of the water is resisted by the weight of the ball, so that the net tendency to rise is the difference between the weight of a volume of water equal to that of the ball and the weight of the ball itself. In the system described, however, the weight of the ascending balls is balanced by the weight of the descending column, or the energy represented by lifting the weights of the ball is offset by the capacity given to the ball to fall through the same distance.

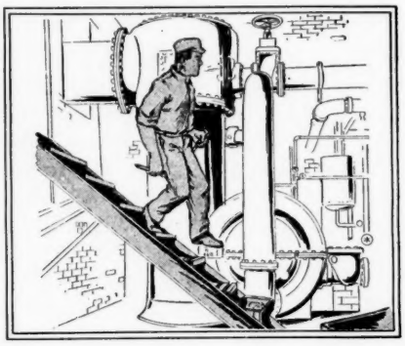


ENERGY EXPENDED, ENTERING

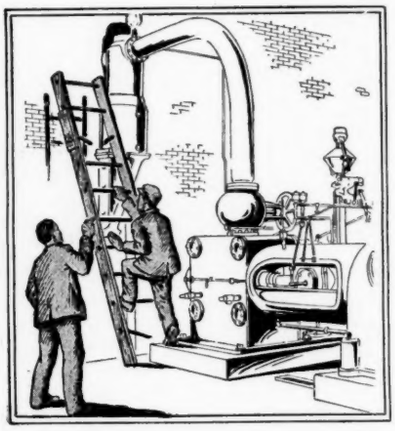
Some Power Plant Don'ts



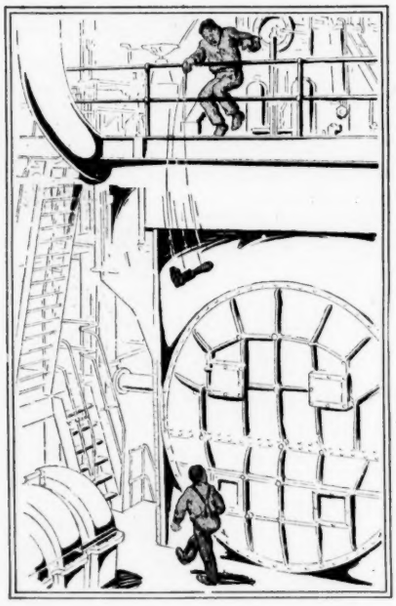
Don't Support a Step-Ladder on a Barrel



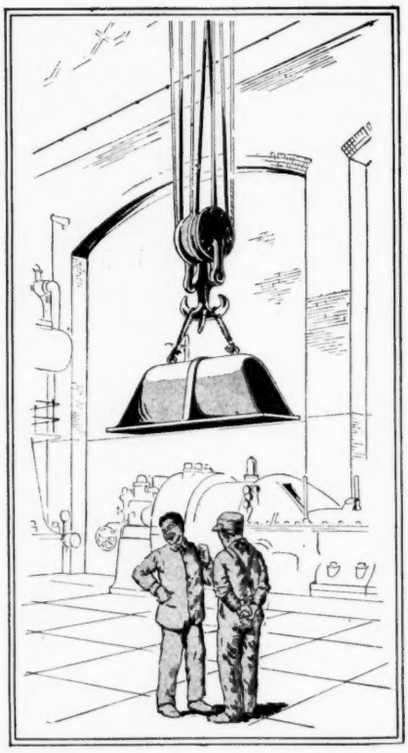
Leaving a Box on Stairway Is Dangerous Practice



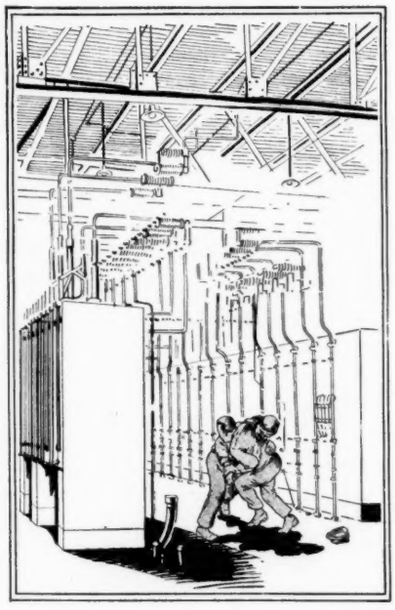
Never Trust Yourself on a Broken Ladder



A Falling Tool May Maim or Kill

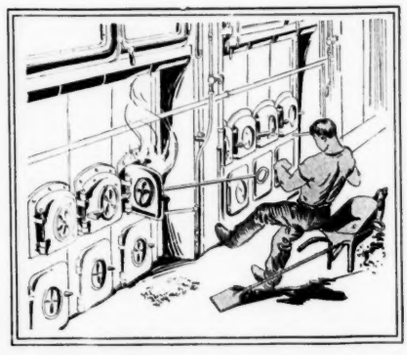


If the Tackle Breaks, Then What?



A Poor Place in Which to Scuffle

Never Startle Switchboard Attendant



Scattered Tools Are Dangerous

He Didn't Watch What He Was Doing

Improved Lagonda Grease Extractor

Improvements have recently been made in the filter and grease extractor manufactured by the Lagonda Manufacturing Co., Springfield, Ohio. As in the design described on page 108 of the Jan. 25, 1916, issue of *Power,* the

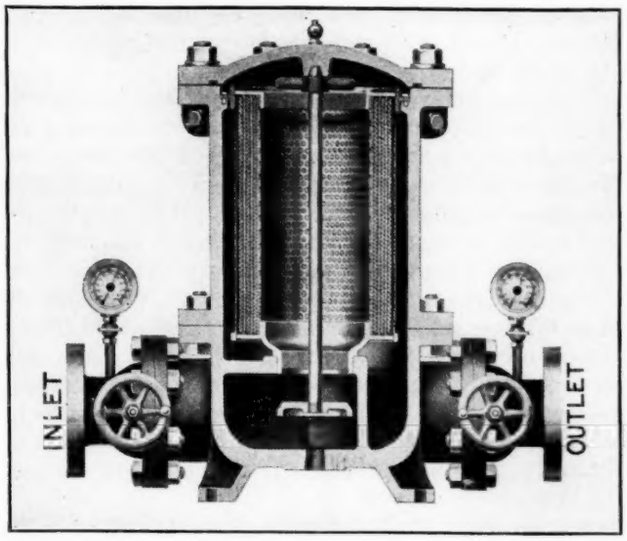


FIG. 1. FILTER CHAMBER IN SECTION

device consists of two chambers, Fig. 3, each of which contains a single filtering element in the form of a spool on which a length of Terry linen is wrapped with the layers separated by alternate layers of a wire-mesh spacing mat, Fig. 2.

All the water is filtered and then refiltered through five layers of filtering cloth. Gate valves at the inlet and outlet control the chambers, and the latter may be cut into or out of service by these valves. The usual

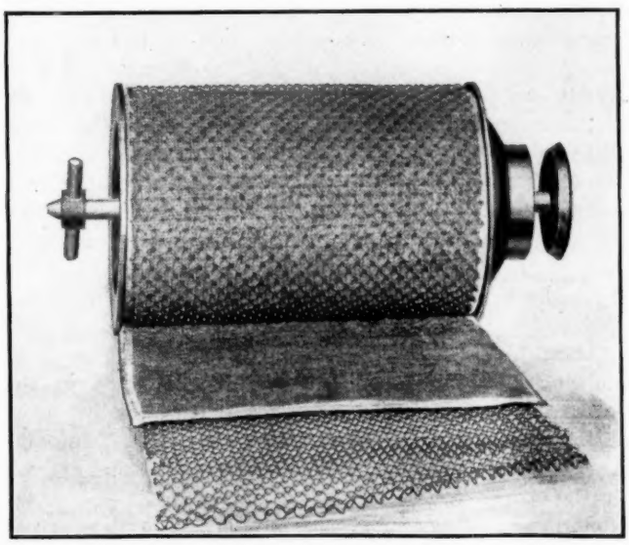


FIG. 2. FILTERING LINEN AND WIRE SPACING MAT OF FILTERING SPOOL

method of operation is to have one chamber in service at a time, with the other one held in reserve. When it is necessary to clean one chamber, the valves are shifted and the reserve chamber is thrown into service and the other opened and cleaned. The cleaning of the improved machine consists in unrolling the fouled linen from the spool and replacing it with a clean extra length. The dirty linen can be washed and used over and over. The filter spool is lifted from the filter chamber by means of a handle at the top of a valve stem. As the spool is lifted out, a valve, Fig. 1, closes the bottom so that all dirt that has accumulated within the core of the spool is lifted out with the spool. When the filter is in opera-

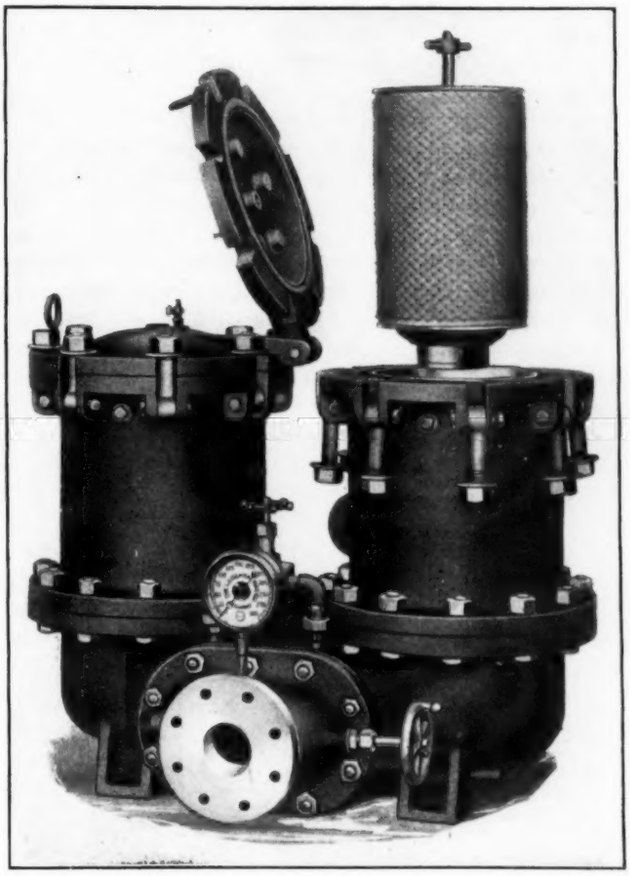


FIG. 3. SHOWING ONE OF THE FILTER SPOOLS REMOVED FOR CLEANING

tion, this valve is held open by the cover which engages the valve stem. An arrangement for flushing out the filter chambers without removing the cover is provided, pipe connections being located near the top of each chamber for a water supply. A blowoff connection is at the bottom of each chamber.

Adjusting Crosshead Shoes

By Morris Ellison

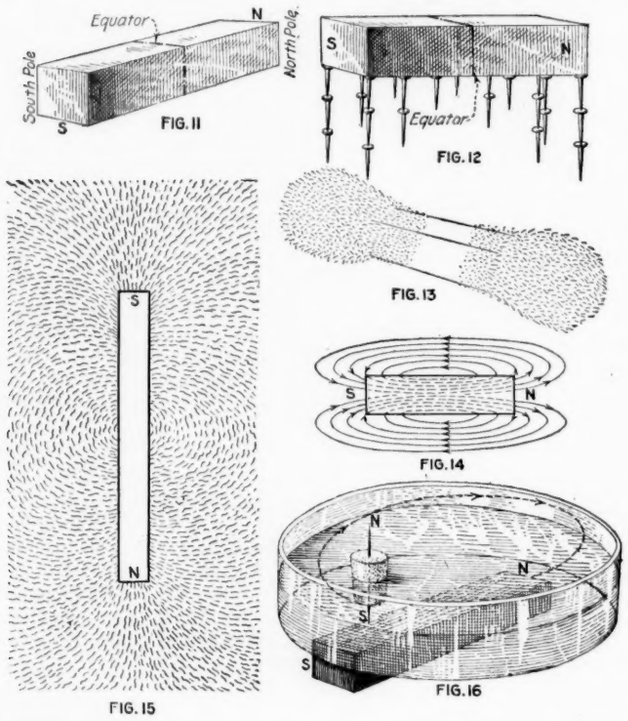
The following method is used in keeping the crosshead shoes adjusted on several Corliss engines: With the top shoe backed off, the lower shoe is carefully adjusted to make the rod parallel. Then a piece of wrapping paper is put between the top shoe and guide and the top shoe is taken up until it pinches the paper, when a few revolutions of the engine removes the paper.

As the engines run "over," practically all wear is on the bottom shoe. When there is clearance enough to allow the paper to slip above the top shoe, the bottom shoe is taken up again as before. The top shoe is good for several years without change of working position and should be brought back to the same mark as long as the rod is still central and parallel.

The Electrical Study Course—Elements of Magnetism—II

SYNOPSIS—The second lesson on magnetism. It treats of the magnetic field, direction of the lines of force, unit magnetic pole and the theory of magnetism.

The ends of a magnet are called its poles and the distance midway between the poles the equator, as shown in Fig. 11. It is at the poles that the magnet possesses the greatest attraction for pieces of iron, and this attraction decreases until the center, or equator, of the magnet is reached, where it becomes zero. This attraction is represented in Fig. 12, where a magnet is shown attracting three pieces of iron at its poles. At a distance in from the pole it will attract only two, a little nearer



FIGS. 11 TO 16. ILLUSTRATE THE DISTRIBUTION AND DIRECTION OF A MAGNETIC FIELD

the equator it will hold but one, and at the equator none. The same effect may be obtained if the magnet is placed in iron filings and then withdrawn, as indicated in Fig. 13. Here it is seen that the filings are bunched at the ends of the magnet, but decrease toward the center where it is clean.

The space outside of a magnet is occupied by a field of influence and is called the field of the magnet or a magnetic field. This field of influence emanates from the N pole and circulates around through space and enters at the S pole, as indicated in Fig. 14. It will be noticed that the greatest number of lines emanate from and enter at the poles, although some of them leave and enter at the side of the magnet. That some of the magnetism exists along the side of the magnet would be expected from the results seen in Figs. 12 and 13; there must be magnetism around the side of the magnet or it would not have attracted the pieces of iron; but, as pointed out before, it becomes less as we approach the equator, where it is zero.

There are many ways of determining the distribution of the magnetism about a magnet. One of the simplest is to place the magnet under a piece of glass and then sprinkle iron filings upon the latter. By gently rapping the glass, the filings will take definite paths, as indicated in Fig. 15. It will be seen that, although the lines are broken, they nevertheless conform very closely to those shown in Fig. 14. After the filings have been arranged so as to show the direction of the magnetic field, if the glass is placed over a sensitized paper, a photograph may be made of the formation. The field of influence from the poles of a magnet is known by various names, such as magnetic field, magnetic flux, flux from the magnet or field poles, and lines of force, but they all mean one and the same thing.

Another method of determining the direction of a magnetic field is illustrated in Fig. 16. A magnetized needle is pushed through a bottle cork and floated in a vertical position in a vessel containing water. If the dish is placed over a bar magnet with the *S* pole of the needle over the *S* pole of the magnet, it will be found that instead of the cork with the needle floating along the axis of the magnet to the *N* pole, it will take a curved path like that indicated in the figure. This is similar to the path shown by the iron filings in Fig. 15.

Lines of Force Conventional

The strength of a magnetic field is expressed as so many lines of force per square inch or square centimeter. This naturally brings up the question of what constitutes a line of magnetic force or how these lines are counted or measured. In the first place, the term "line of force" is only figurative, because in the true sense, or at least as far as we know, such a thing as a definite line does not exist. Therefore, the lines which are generally shown in pictures of magnets are used only to indicate that there is a flow of "something" from the N to the S pole of the magnet and the direction of the flow.

If we were to place two fans so that when they were running one would be blowing against the other, the force of the air would tend to cause them to separate. If they were suspended from long cords and a spring balance connected between them, the force that one exerted on the other could be measured.

Suppose, for example, that the fans tend to separate with a force of 10 oz. If, instead of calling this force ounces or pounds, we called each ounce of repelling force a line of air, it would be the same thing that is done in measuring the strength of a magnetic field; only in the magnetic measurements a unit called a dyne is used. This unit is known as the centimeter-gram-second (c.g.s.) unit and is equivalent to $\frac{1}{445000}$ lb.

If the like poles of two magnets are placed one centimeter (approximately ¼ in.) apart, as shown in Fig. 17, and they repel each other with a force of one dyne, the

magnetic field is said to be of unit strength. Therefore one line of magnetic force is just what the term would imply; namely, a force, just as one fan blowing against the other created a force which tended to separate them.

To express the magnetic unit more accurately, when two magnets of equal strength, of one sq.cm. cross-section each, are placed one centimeter apart in air and repel each other with a force of one dyne, they are said to be of unit strength. In this case the field of the magnet is said to be of unit intensity—that is, one line of force per square centimeter—and is called a gauss, after Karl Frederick Gauss, a German scientist. So we see there is nothing mysterious about this unit; it is a unit of measurement just as the pound or ounce is.

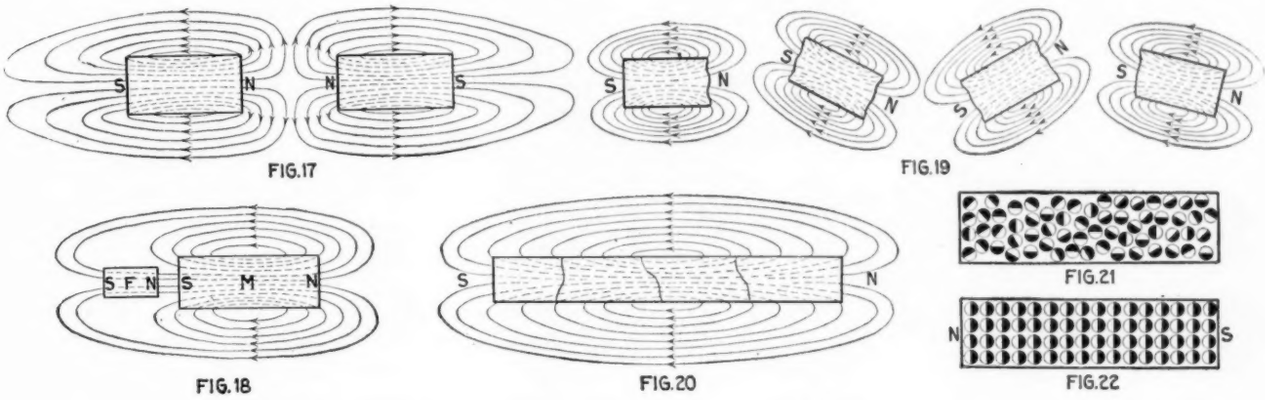
In the previous lesson we found out that a magnet would attract a piece of iron or steel, but had little or no attraction for other substances. This naturally brings up the question, "Why is this so?" Anything that a magnet can magnetize it will attract. When we say that a magnet will attract a piece of iron, it is not a true statement. What really happens is that the piece of iron is first made a magnet and then the magnetism in one attracts the magnetism in the other. In Fig. 18 is shown a bar magnet *M*. If a piece of iron *F* is placed as shown, it will become a magnet having N and S poles, as indicated. It will be seen that the end of the iron nearest the S pole of the magnet has become an N pole and that some of the lines of force from magnet *M* are passing through the piece of iron. We have previously found out that unlike poles attract, therefore if the end of the iron next to the south pole of the magnet is made a north pole, it will be attracted by the S pole of the magnet. This is why a magnet will not attract other substances—because it cannot first make magnets out of them.

The foregoing brings up another important question, "Why can a piece of iron be magnetized and most other substances not?" The answer to this is found in the theory of magnetism. If a bar magnet is broken into several pieces, as shown in Fig. 19, each piece will be found to be a magnet with a north and a south pole, as shown. This experiment can be easily made by magnetizing a hack-saw blade and then breaking it into several pieces. Each piece will be found to be a magnet. If the parts are placed together again it will be found that the magnetic pole of each piece will disappear at the division and be present at the two ends, as shown in Fig. 20. There is one conclusion to draw from this fact, and that is, if the magnet is broken up into infinitely small pieces, each piece will be a magnet with a north and a south pole.

There are many theories of magnetism, but the one given preference today is based on the foregoing hypothesis. It must be remembered that just what magnetism is, is a scientific question that is not settled. What is generally accepted is that each molecule of iron is a magnet in itself. Under natural conditions the molecule takes a position so that the poles of one neutralize those of the other, as shown in Fig. 21, just as the poles of the pieces of magnet in Fig. 20 neutralized each other when they were brought together. When the pole of a magnet is brought near a piece of iron, it will attract the opposite pole of the molecules and pull them around in a systematic form, as in Fig. 22, and the lines of force of one molecule will pass into the other and appear only at the end of the piece of iron, just as the pole of the pieces of broken magnet did in Fig. 20.

Of the many theories of magnetism, the one just given perhaps best accounts for the different magnetic phenomena and was first advanced by Wilhelm Eduard Weber, a German scientist. It accounts for the fact that a piece of soft iron will remain magnetized only while under the influence of another magnet and a piece of hard steel will remain permanently magnetized when once magnetized. The iron being soft compared with hard steel, the friction between its molecules will be less; therefore, when a piece of iron is put under the influence of a magnet, its molecules will be easily arranged systematically, or in other words, easily magnetized. When taken away from the influence of the magnet, the molecules can easily arrange themselves so that they will neutralize each other and the iron will become demagnetized. With hard steel, however, the friction between the molecules is high, and it is much harder to magnetize than a piece of soft iron. But the friction that causes the steel to be difficult to magnetize will tend to hold the molecules in a systematic arrangement after they have once taken such a position, and the steel remains magnetized, or in other words, a permanent magnet is obtained.

After steel is once magnetized, it will remain so indefinitely unless subject to some outside influence such as that of another magnet or vibration. If a permanent magnet is hit a few times with a hammer, it will be found to have lost its magnetism. This is caused by the molecules vibrating when the piece of steel was hit. The



FIGS. 17 TO 22. EXPLAIN MAGNET ATTRACTION AND THE THEORY OF MAGNETISM

effect is similar to that of placing grains of sand on a plane that is slightly inclined. As long as the plane remains motionless, the sand will not move down its surface, the friction between the plane and the sand being sufficient to prevent the latter from moving. If the plane is struck with a hammer and caused to vibrate, the sand is loosened up from the surface, or in other words the friction is decreased, and it gradually works down the plane. Similarly, in the permanent magnet when it is hit with a hammer the molecules are caused to vibrate, which decreases the friction between them, and they gradually pull each other around to a position where their poles neutralize. The same effect is obtained by heating the magnet. This is due to two reasons: First, the steel loses its hardness, and secondly, heating causes the molecules to vibrate as when the magnet is struck with a hammer.

In Lesson II it was pointed out that a magnet imparted its properties to a piece of iron without any apparent loss. From what we have found out about the theory of magnetism it is evident that a magnet does not really impart its property to a piece of iron, but rather makes manifest those properties already in the iron; therefore, the magnet is not subject to any action that would cause a loss.

More Fake Fuel Savers

A number of new candidates for "easy money" in the guise of fuel savers appear in the nontechnical press. The first is an advertisement that appeared in the New York *World*, Sunday, Dec. 3, 1916:

AGENTS—Coal is high and going higher; now is your opportunity; build permanent business and make money; marvel coal saver; chemical solution, guarantee three tons to do the service of four tons. Free sample offer to good agents. Travers Chemical Co., Box 42, New Brighton, S. I.

The second is from the New York *American*, Sunday, Jan. 7, 1917, and is as follows:

REDUCE YOUR COAL BILLS

Koalsave powder is guaranteed to cut your coal bill 25 to 35 per cent.; gives brighter, hotter, more lasting fire and no clinkers; costs 10c., retails 50c.; buy own ingredients and mix them yourself at small cost; formula, with full directions and generous sample to make convincing test, prepaid 25c. Agents can reap harvest of dollars. The Oliver Specialty Co., Altoona, Penn.

A third is herewith reproduced from an advertisement in *The Coal Dealer*, of Minneapolis, Minn.

Another, called "Radion," is manufactured by the American Radion Fuel and Sales Co., Colorado Springs, Colo. Its analysis is as follows: Sodium hydrate (caustic soda), 20.80 per cent.; sodium sulphate (Glauber's salts), 25.40; sodium chloride (common salt), 24.60; calcium carbonate (limestone), 19.40; zinc carbonate, 8.80; aluminum oxide, 0.80; phosphoric acid, trace; nitric acid, trace. The sample dried at 110 degrees Centigrade before analysis showed one per cent. moisture.

Sodium hydrate (caustic soda) has no heat value comparable with coal and cannot be used as fuel or combined with it except at a loss. Glauber's salts is one of the components of the "salts and senna" by periodical administrations of which the budding Yankee was kept upon the road to health, and is not a fuel. Sodium chloride, or common salt, has been used for years as the base for such nostrums because it produces a spectacular varicolored flame when thrown on a hot fire—and incidentally it is quite commonly used to extinguish chimney fires. Calcium carbonate or limestone is freely used in blast furnaces as a flux, but not as a fuel. The trace of nitrate is due to the small amount of perfume (scents for dollars) in the sample. While this combination of materials is a strong flux and may have a tendency to reduce the volume of ash, it does not reduce its weight.

This mixture, even at the present abnormal prices, can be compounded in quantities for a few cents per pound, but is sold at thirty-five to fifty cents. It is to be dissolved in water and sprinkled on the coal before it is fired. There is nothing in the mixture or the method of using it that can possibly add to the thermal value of the fuel or in any way justify the extravagant claims for it.

Mr. Dealer:-

Coal is Coal and Dealer-competition is strong. Why not treat your coal scientifically, increase its heat value, reduce the ash and cinders, make it equal to higher grade coal and sell at the higher price? Your profits increase accordingly.

This is no theory but a positive, proven principal and we want *you* to prove it at *our risk.*

Nitro-Ignitum

Makes Permanent Coal Customers
15% More Coal Profits

NITRO-IGNITUM burns all the carbon in coal and practically all the sulphur. Nothing wasted in smoke, soot or cinders when intelligently fired. Every buyer becomes a permanent customer—and a booster—for your coal. Will bring more new customers than several salesmen, at only a fraction of the cost. DO THIS NOW.

WRITE FOR FULL PARTICULARS.

Hickok & Co. Title Guarantee Bldg. St. Louis, Mo.

REPRODUCED FROM "THE COAL DEALER"

It is and has been our policy to expose and denounce all such nostrums whenever brought to our attention. No engineer should be misled or deluded by such claims.

Hydro-Electric Machinery Demand from Italy—According to telegraphic reports reaching this country from Italy, it appears that the shortage in the coal supply is steadily increasing and that a corresponding rise in coal values has taken place, bringing the price up to $50 per ton. This is $10 more than during last winter and opens a dreary prospect for those industries that are compelled to use coal. Italy has very little coal of her own and consequently of late has given great attention to the development of her hydro-electric resources. These resources are large, owing to the numerous streams flowing down from the Apennines and the Alps. The entrance of Italy into the war has interrupted the developing work done during the years 1910 to 1913. Now, in consequence of the serious pressure put on the government by interested parties, new steps have been taken to hasten work wherever possible and a number of both small and large projects have been taken up. This opens a new field for American exporters of water-power machines, especially as now, after the declaration of war against Germany, no machines will reach Italy from that source. Before the war Germany used to send yearly a number of new water-power machines, mostly of small size, to Italy. Others were sent from this country and from France, Austria and England. With the exception of the United States none of these countries at present will be able to supply such machines, and it seems that offers made just now might lead quickly to business.

Editorials

The Closed Mind in Engineering

"Beware of the closed mind," said Senator Henry Cabot Lodge at the dedication of the new buildings of the Massachusetts Institute of Technology; and better advice was never offered to members of the engineering profession. It might seem as though the engineer needed such counsel far less than most men, considering the rapid development of the past quarter-century in the field of power production and in other great constructive and operative enterprises. Yet immersion in routine threatens intellectual liberality; it tends to stiffen opinions and to make the entrance of new ideas harder. Surrounded by the pressing responsibilities of his daily working cycle, the operating man in particular needs to learn to look beyond the present and to visualize the opportunities of the future.

By cultivating the scientific spirit—the "I'm from Missouri" attitude of the man in the street applied to technical service and its foundations—one finds a new outlook upon routine. In fact, it may cease to be routine if the spirit of scientific inquiry gets a fair chance to develop in the engineer's local world. The closed mind leads him to believe that his particular installation continues to represent the last word in practice; to dismiss the suggestion that some pet scheme may be unsuited to the local conditions, to look upon an hour's visit from a salesman dealing in "foreign" equipment as more or less of a waste of time; to judge his neighbor's installation from its superficial aspects; and to discount the opinions and suggestions of subordinates as the products of half-baked imaginations.

In modern engineering nothing is justified unless proved the best under the conditions; and when the conditions change, new proofs must be forthcoming. Here comes the City of Boston, for instance, attacking through engineering testimony certain features of the L Street Station of the Boston Edison Company as an unnecessary investment and therefore one upon which street-lighting rates should not be based. Here are engine-driven generators and even a turbo-alternator declared unnecessary for the company's present operating needs by Mr. Pigott, as an outside critic of the system on behalf of the city. The company comes back, of course, with testimony that its engineering needs demand the retention of this apparatus, and the pros and cons of this question are of much interest. The significant thing is, however, that until recently, the installation of the apparatus under discussion had been accepted as a matter of course; but now that the rate structure of the company is resisting a drive against that portion of its front occupied by street-lighting charges, the owners of this power-plant equipment must show the reasons for the installation and retention of the hitherto undisputed equipment.

The open mind and the spirit of discontent with things as they are, are responsible for progress. Problems in station engineering may be settled for the time being, but finality is far from attainment.

China an Exceptional Field for Power-Plant Materials

There appears in this issue an article on "The Electrical Power Industry in China and Indo-China," which is worthy of more than the passing notice of those who are interested in foreign markets for American-made machinery. China is a nation with about four and one-half times the population of our own country and approximately one-fifth greater land area, yet if it were possible to get accurate data, it is doubtful if the total capacity of all the electrical generators in use in China would be found to be equal to that of the largest generator under construction in this country at the present time. But this is the China of the past. What the manufacturers of electrical materials and the electrical engineers are interested in is the China of the future, and for the manufacturers of power machinery here seems to be offered an exceptionally promising field. The market is still in its development, and at the present time there is just that disturbance in the relation between sellers and buyers which, as a rule, helps the newcomer. The war in Europe has brought about changes in the national groups of electrical importers in China, and these finally may free this market from that virtual control which formerly has been exerted on the Chinese electrical business by a number of antagonistic interests.

It is borne out by statistics that the use of electricity for both power and light is increasing in the Far East. That China is alive to the future possibilities of her own electrical-power industry is attested by the fact that the Engineering Society of China has already adopted standardization rules that are to be followed in the future development of her electrical industry. Manufacturers willing to enter the field should secure representation in one of the leading cities of China. Preferably they should be represented by American houses, provided they can find such houses willing to handle Chinese business as it should be handled. The losses to which American exporters have been exposed during the last two years, in consequence of the animosity between firms of different nationalities, should prove a warning to others.

We are supplying China today with a considerable amount of power-plant material, but we are still far from having built up a market. Many American import houses in China so far have not risen to the occasion. What the American engineering industry needs in China today is American engineering bureaus working on the principle of the English and French concerns of the same class. These are enterprises which as a rule represent a number of different manufacturers and also will take orders for others when there is a chance. The main advantage for the exporter lies in the fact that they often carry out the total construction of engineering enterprises and in doing so are able to put a good deal of business in the way of their home firms. Our Foreign Consuls and Foreign Trade Advisers are doing an admirable work for the

American manufacturers, in furnishing reliable information as to the needs of the various foreign markets, but their efforts are of no avail unless taken advantage of by the manufacturers and an endeavor made to fill these needs.

The list of cities having electrical stations is still small. The fact, however, that many of these cities have several power stations show that China has become accustomed to the use of electricity; all that has to be done is to extend the use. The best way of doing this is to add new power houses to the existing ones. In the past English, French, German, Belgian, Russian and Japanese capital has been especially active in this kind of developing work. American capital still seems to be lacking. To make the American electrical industry prosperous in China, American capital will have to take on its obligations and support American enterprise, either jointly with Chinese interests or independently. It will be found that in this case capital will have to lead the demand—not follow it. The demand for electrical power has to be created in China, and undoubtedly she may thank other nations for having offered the facilities for power supply without waiting to see whether there would be an immediate demand. America today will have to show the same spirit of enterprise. This does not mean that American engineers and capitalists should erect plants in the hope that they will pay for themselves at some future time. But they will have to act on their own initiative, picking out suitable districts and supplying them with power and light. They will, in doing this, find as a rule the support of the Chinese merchants and also of the European population. If the plant is kept in proportion to the demand that can be expected, there will certainly be a profit.

The development of China's electrical possibilities cannot be handled on the same principles as would be applicable, for instance, in South America. The market, however, has the great advantage that there are plenty of chances for those who are first in the field. Every year new cities are opened for international commerce. Each of these cities will eventually be lighted by electricity and its industries will use electric power. The manufacturer or the company entering the market while it is still young will be able to start with a comparatively small outlay and will grow to proportions which are limited only by the growth of the city and its surroundings. China today is a "West" with a 440,000,000 population. Nobody knows how she will develop finally, but everyone who has lived in China expects a great economic future for her. The American electrical industry seems to be entitled to a share in this development.

Safety in the Power Plant

In this day of efficiency experts and efficient workers laboring at concert pitch, it is small wonder that lawmakers and farsighted business men have recognized the importance of the safety movement. No one can point out all the different kinds of danger there are in American industrial life. To mark them all "Danger" or to buy every safety appliance made would not preclude all accidents, nor even a considerable percentage were it not for the moral effect of the use of the appliance. It is the education of the workman, through literature or pictures, conversation or example, that brings the greatest result in decrease of accidents. In other words, the "safety thinking"; that continual inner voice warning the worker of possible dangers, that lends itself naturally to the education to further precaution.

The idea of safety in the power house is predominant. We find, or should find, safety valves on all boilers or similar vessels, keeping the pressure within safe working limits; nonreturn valves, low and high-water alarms, overspeed devices, electrical appliances—a countless number of devices to protect apparatus and property, as well as the operators. Yet it is up to the engineer to start his men thinking safety for themselves as well as the apparatus.

How often does one see a man striking a cold chisel or bar with the head mushroomed so that there is danger of flying bits of metal, or, when sent to the emery wheel, paying little heed to his eyes? Over 80,000 glass eyes are worn in the United States annually because of carelessness or lack of eye protectors. When working in the firebox or combustion chamber, men will appreciate a good pair of goggles or a dust hood to cover the whole head and shoulders, and the engineer's requisition for them will be appreciated by the average manager. Many will recall seeing handhole plates piled too high on the staging and thus endangering those below, or the carelessly thrown slice bar to be tripped over. These little things are just as criminal as an unguarded belt that causes an accident.

Take a walk through the plant today with the safety idea in mind and see where you can instruct the men for the good of all concerned. See if a few signs about "Valve Closed" or "Live Wires" might not be applicable. See whether the improvement or addition of lighting would not remove an element of danger. Get knuckle guards on wheelbarrow handles; goggles, rubber gloves, safe ladders and other apparatus for the men. These are only general hints, and the engineer will think of a hundred more precautionary measures. Above all things, get the cooperation of the men in the use of them. An unsafe man is the weakest link.

The Division of Boiler Inspection of the Industrial Commission of Ohio has adopted the following resolution:

> On and after July 1, 1917, all fire or furnace doors used in connection with the settings of steam boilers shall be provided with some satisfactory device to hold them permanently closed during the interval between firing or cleaning fires in furnace, and all such installations shall be provided with a door or other device in the rear of these settings, to protect the walls in case of tube rupture or explosion of gases.

The disastrous consequences of many a tube or gas explosion would have been avoided had this rule been in force, and we congratulate Chief Deputy J. C. Callery and those associated with him for their progressiveness in adopting it for the State of Ohio.

The sixty-odd replies received in reference to the perpetual-motion schemes analyzed in this issue showed that while the subject might be approached in a number of ways, to put the analysis in a direct and convincing manner is rather difficult. However, let none of the contestants feel that the time given to the problem has been wasted, for the benefit derived from such a study lies not so much in merely proving that someone was wrong, honestly or otherwise, as in developing the faculty for clear reasoning—an invaluable asset to all engineers.

Correspondence

Backing Off the Gland

A few months ago several letters appeared in *Power* as to various methods of determining the distance the gland on the piston-rod stuffing-box of an ammonia compressor may be safely backed off. I believe a more satisfactory method than any described is to file a flat spot on one or two of the threads at a point where they will correspond with the face of the gland when it has been backed off as far as safety permits. It is then easy to determine the relative position of the gland even in the dark, by simply placing the fingers on the threads. Of course the value of this or any other means exists only in the observance of it, as the following incident will show:

My first experience in operating an ammonia compressor was when I was given a night run in a plant, part of the equipment of which was a 16-ton horizontal compressor, which I was instructed to start about midnight.

Before I took over the watch, one of the engineers showed me about the plant to familiarize me with my duties, and in speaking of the compressor, which was not running at the time, he told me if the rod should run warm I might back off the gland. I asked how far it could be backed off safely, and he said there were two flattened threads which, when uncovered were supposed to indicate the extreme point of safety, but that he had backed the gland off beyond them several times without trouble. To demonstrate he began to back the gland off, leaning over it to observe its position, when suddenly the gland blew off, the packing and oil lantern were forced out and his face and hands were covered with ammonia-saturated oil, which blinded him for half an hour.

We replaced the packing and oil lantern and screwed the gland on again, thinking no damage had resulted; but when I started the machine, I noticed that the oil level in the reservoir of the circulating system feeding the piston rod gland was dropping rapidly. I took up more on the gland, which resulted in the rod running warm, but the oil level still continued to drop. Being unfamiliar with the machine, I was puzzled but managed to get through the watch by refilling the reservoir several times. Before going home, I reported the loss of the oil, but said nothing of the accident. The machine was repacked during the day, but upon starting again the next night I began to experience the same trouble. This time I noticed that a squirt of oil accompanied each outward stroke of the piston rod, and the oil level dropped so fast that I saw it would be necessary for me to do nothing else but pump oil into the system if I was to hold the level. I called up the chief, who came over and took a look for himself. We then shut down the machine and examined the rod, in which we found a nick, the back of which formed a knife-edge protruding a sixteenth of an inch from the side of the rod. This edge working back and forth had cut a groove in the packing. I knew immediately that the nick had been formed when the gland had blown off.

After filing the edge off and repacking the stuffing-box, we had no more trouble, yet the chief was somewhat puzzled as to how the nick had been made. Finally he decided that he had caused it himself, as the gland had pinched the rod when he had taken it off the day before, but he concluded that the rod must have been pretty soft.

Del Monte, Calif. A. C. McHugh.

Overhauling Pop Safety Valves

In regrinding a number of pop safety valves I saw the necessity of providing a quicker and more accurate way of facing the seats, as we have several hundred pops of

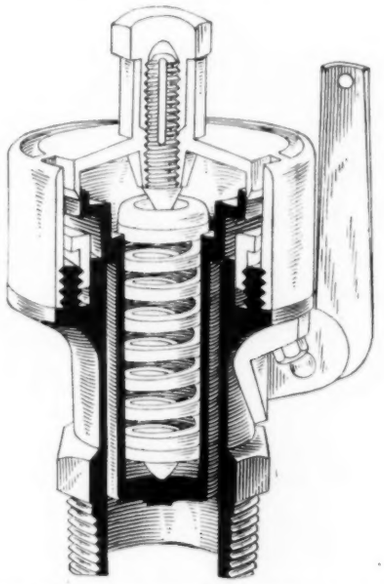


FIG. 1. THE TWO PARTS INVOLVED ARE SHOWN SHADED

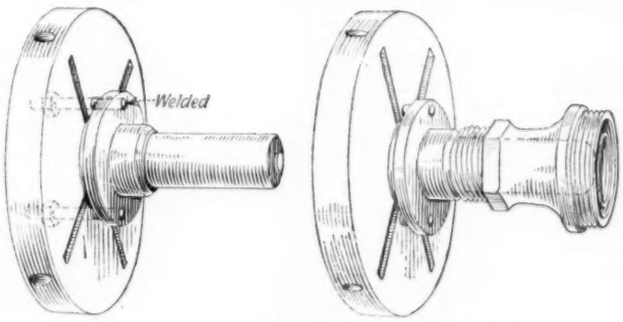


FIG. 2. PARTS CHUCKED FOR THE CUT

all sizes on the job. I made a clamp for each size, to hold the disk against the faceplate of the lathe, as shown in the illustration.

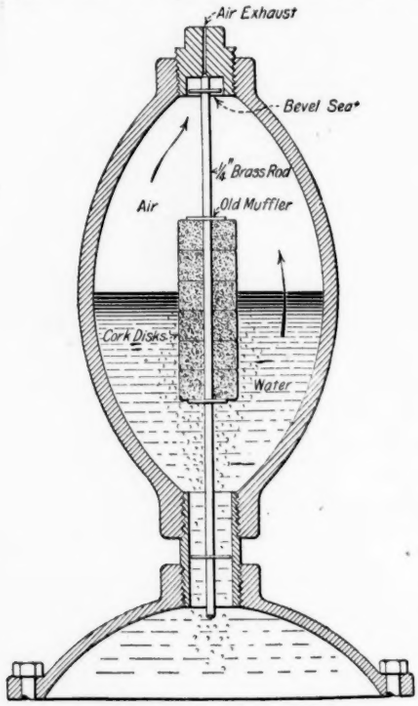
In this particular make of valve the disk is machine-finished all over, therefore all surfaces will run true with one another. After removing all scale and burrs, the valve disk is clamped and centered to run true and the disk is faced off. The valve body is then slipped over the guide of the disk, in a reverse position, the bottom of

the valve to bear against the shoulder at the base of the seat. Care should be taken to see that nothing prevents the body and seat from making a square contact. A thickness of paper sufficient to make the guide fit close enough into the body to drive it when a cut is taken must be used. When dressing the seat in the valve body, feed the tool toward the work so as to tend to hold it in position, for the body being held by friction, care must be taken, but plenty of power is available for the cut, as it is merely a truing operation. By this method the faces of the seats in body and disk are of the same bevel and true with the guide and only enough grinding to remove the light tool marks is required. I have in this way reduced the time from four or five hours in chucking both pieces separately and hand grinding, to one hour for all operations in the lathe. Fig. 1 shows, in heavy lines, the two parts of the valve that are operated upon, as shown in Fig. 2. The central part is the disk with the guide extending well down in the body, and the upper part of the body forms the valve seat. A. H. Yoch.

Hazleton, Penn.

Air Relief on Pump Discharge

We were constantly annoyed by air in the suction pipe leading to our water-supply pump at the United States dry dock here. The 4-in. pipe, about 150 ft. long with an 8-ft. lift, is designed for fire service as well as for the ordinary supply about the grounds. The water passes so



AIR VENT ON PUMP

slowly through the pipe under ordinary circumstances that air collects in the pump and the discharge loses its pressure and allows the pump to run away. It occurred to me to get rid of the air in the manner shown.

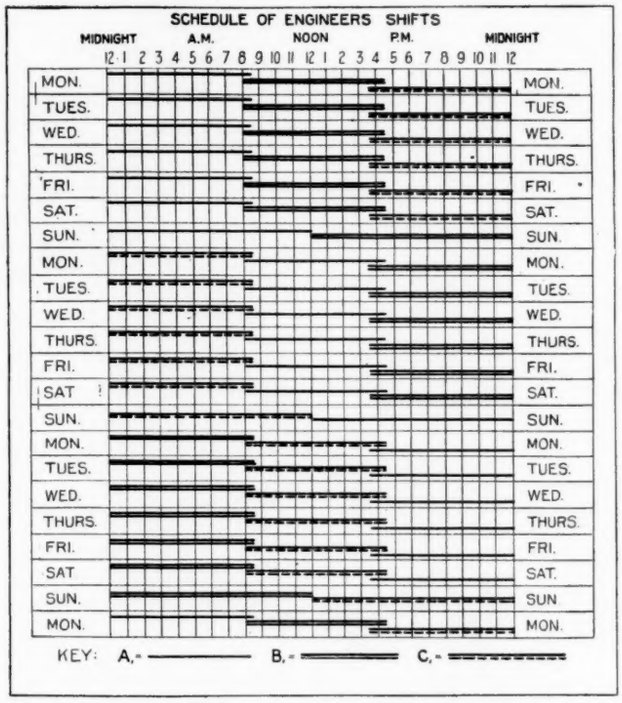
A 2-in. nipple was screwed into the cap on the pump chamber and an old muffler of cast iron was connected, as shown, with a float, etc., to act as an air reservoir and relief so that when the air collects it is automatically discharged and the pump keeps on working, discharging air from this snifter valve and water to the service main. This has given entire satisfaction and works perfectly without any attention. We do not think there is any leak in the suction pipe, but simply a separating out of air from the water due to the vacuum. In cold weather apparently there is more air in the water than in hot.

A glass of water drawn from the city mains in cold weather looks milky, with air bubbles, and it is this dissolved air that our snifter takes care of.

Keokuk, Iowa. M. Meigs.

Watch Engineers' Time Schedule

In the graphic schedule submitted by William N. Scammon in the issue of Dec. 26, page 894, there appears to be room for much improvement, as the men are not given one day off each week, but simply divide up the time between themselves in order to get any time off;



SHORTER OVERLAP THAN PREVIOUS SCHEDULE

therefore they actually work seven days a week. It would seem that an overlap of one-half hour in the morning instead of one hour and an overlap of one hour in the afternoon instead of the nonsensical two hours would be adequate. If so much overlap is necessary at one time, it would also seem to call for some at midnight.

We have established the half-hour extension (8 to 8:30) for the men going off watch and one-half hour each at 4 for the two afternoon watches, one reporting in at 3:30 and the other staying on duty till 4:30, making an overlap of an hour. In shifting the watches, one man works 51 hr. a week instead of 69 (as in Mr. Scammon's schedule) and two of the 12-hr. watches are eliminated. Our men work 177 hr. in three weeks instead of 183 hr. We have an extra man who stands watch once each week, thus giving each watch engineer one day off in three weeks. James G. Sheridan.

Brooklyn, N. Y.

In reference to Mr. Scammon's way of working three shifts, I wish to tell how we operate every day in the year, working three 8-hr. shifts except Sunday, when two

shifts do the trick, the day shift working from 6:30 a.m. to 5 p.m. and the afternoon shift from 5 p.m. to 6:30 a.m. Monday. This gives the night shift of the previous week a day off, and each shift in turn has one Sunday off in three weeks.

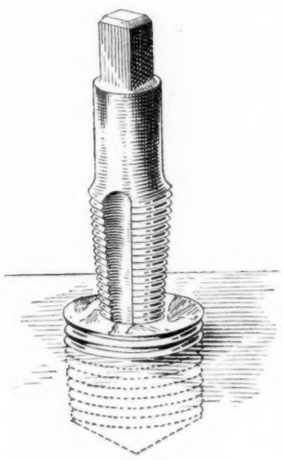
We have a daily report sheet on which we record the condition of the machinery and the repairs made during each watch, and we also report to our relief such conditions and repairs. By this method it is unnecessary for the crew going off to stay any longer than the specified time. The plant must be in good condition, or the shift will not be relieved; and there is no way to play false in the face of the report, which is also examined by the chief engineer. Credit for the good operating condition of the plant goes to each shift whether on or off duty, therefore it is to the credit of the crew to try to put it in A1 condition for the man coming on, as well as to keep it so while on duty.

If this system of reports is used, I do not think it necessary for any shift to work longer than the regular 8 hours.

Minersville, Penn. EDWARD. H. QUINTER.

Removing Broken Studs

For some years I have been using the "old approved method" of getting out broken ends of cap-bolts, etc., as shown in the illustration, and find it satisfactory. I first center-punch, then drill a hole about half the full diameter of bolt, and not quite through the length of the broken end. I have a short and stout plug ta , with a left-hand thread, that I insert and cut a left-hand thread until the tap bottoms in the hole. Then by a little force the broken end of the bolt will in most cases unscrew, leaving the tapped hole in perfect condition for a new bolt. Driving in a square drift does not always prove successful, but the left-hand thread tap draws itself in and there is no slip, and by reasonable care the tap will not break.



LEFT-HAND TAP TO UNSCREW STUD

CHARLES L. DAVIS.

Leicester, Mass.

Cast-Iron Fittings Unreliable

An accident which occurred at the plant where I am in charge as engineer showed me that it does not pay to use cast-iron fittings in boiler work.

On looking in the combustion chamber one Saturday, I saw that the blowoff pipe was bulged and in a dangerous condition. I at once ordered extra-heavy pipe and a 2-in. ell to replace the line on Sunday, as we were going to clean the boiler at that time. We found that we could get the pipe all right, but could not get an extra-heavy malleable ell short of Pittsburgh, with delivery uncertain. So we used a cast-iron ell instead. I put the new pipe and ell in on Sunday and went home, after building a fire so the night watchman could raise steam.

Everything looked all right at 6:30 on Monday morning, so I started up the plant and ran till 11:30, when there was a dull roar and the clean-out and firedoors flew open and steam blew out from one, fire from the others. A piece about 1 in. diameter had blown from the side of the ell and the boiler was emptied in short order. When the boiler had cooled enough, I went in and disconnected the pipe, replacing the ell with a regular stock malleable ell. The cast-iron ell was about $\frac{1}{16}$ in. thinner on one side than the other. Such a defect is hard to detect, and this makes cast-iron fittings unreliable.

East Liverpool, Ohio. JOHN F. CURREN.

Oil or Compound Feeder

I have often wondered why someone did not place upon the market a pressure fluid feeder, for feeding lubricating oil to a steam engine, to take the place of the condensate gravity-head type so common in use. Something similar to the following, would, I believe, possess superior advantages.

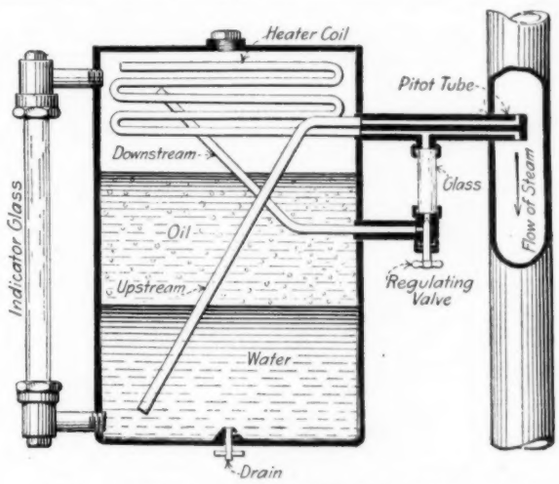


FIG. 1. PROPOSED PRESSURE LUBRICATOR

By introducing a pitot tube of conventional design into the steam line, using an orifice plate or throat piece, if necessary to obtain velocity to give sufficient venturi head or differential pressure, would it not be possible to obtain better results than with gravity-type lubricators?

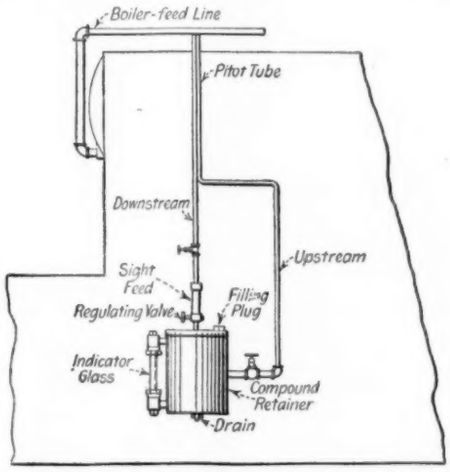


FIG. 2. USED ON A PRESSURE COMPOUND FEEDER

Lubricators of the constant gravity-head type feed a quantity of oil dependent upon how they are manually

adjusted, and the oil feed does not vary as it should with either an increase or decrease in the piston speed or with a greater or less steam consumption. The ordinary lubricator continues to feed oil whether the unit is running or not, unless it is shut off, resulting in a waste of oil.

With a fluctuating load and its attending increase or decrease in steam consumption or piston speed, such as is found in hoisting engines, air compressors or other like units, the quantity of oil fed to the cylinders should be in proportion to the volume of steam used and the piston speed and not uniform for changing conditions. A lubricator based on the above principle will, I believe, accomplish this.

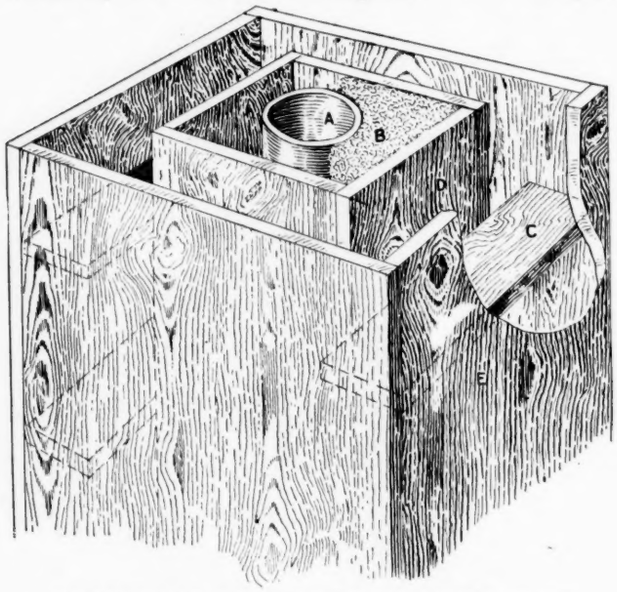
The adoption of a lubricator of this kind for use on steam shovels, dredges, hoisting engines, steam hammers, locomotive and yard cranes, logging engines and in fact on air compressors, pumps, etc., controlled by throttling governors, would prove very efficient.

The same principle may also be used to advantage to feed compound to boilers by utilizing the boiler feed lines in the same manner, as shown in Fig. 2. The quantity of compound introduced could be regulated to conform to the rate of evaporation. THOMAS R. TARN.

Pittsburgh, Penn.

Water-Pipe Frost Protection

In cold climates, outside water pipes should be boxed somewhat as shown in the illustration. *A* is the pipe to be protected, *B* is dry sawdust with a small quantity of unslaked lime in it (when so treated rats and mice will leave the box severely alone), and *D* is the inner box containing the sawdust, allowing about 2 in. of space



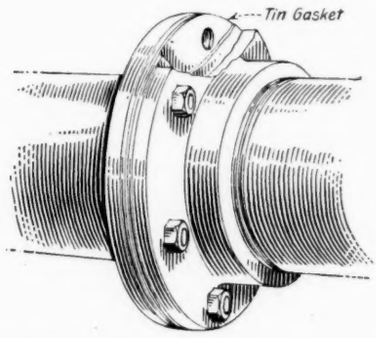
CASING TO PROTECT WATER PIPE FROM FROST

clear of the pipe. The inner box is made of ⅞-in. boards, and the outer box *E* of 1¼-in. boards. At intervals strips of wood about 2 in. wide are nailed on, as at *C*, to hold the inner box central. Care must be taken to make a tight job of the outside box, as it is necessary to prevent a circulation of air to any extent in the space between the boxes. Cut straw, asbestos, cement, powdered mica, mineral wool or ground tanbark can be used instead of the sawdust if desired. JAMES E. NOBLE.

Kingston, Ont., Canada.

Reinforcing Double Gaskets

The writer had to contend with a piping job where the pipe was skimped over the entire layout—that is, cut too short or slightly under dimensions—and in order to bring up some of the joints without undue strain it was necessary to use double gaskets between the flanges. While some of these held tight when the pressure was put on, others gave way or began to leak slightly, and even



TIN DISK BETWEEN GASKETS

after making some replacements it was not possible to keep all the joints tight. Someone suggested that the gaskets should be strengthened or supported in some way. We tried this out by placing a tin gasket between the regular gaskets on several of the troublesome joints, as shown in the illustration, and they are now holding tight.

Philadelphia, Penn. M. A. SALLER.

The Coal Problem of Today

What is to be done with this most perplexing coal question that is just now causing us all (not only those operating plants but domestic consumers also) worry and additional expense? It would not be so bad if the price alone was changed; but the operators get together and change the size of screens, reducing the size of the coal almost annually, add 15 per cent. or more of foreign matter as bone and slate to the already poor fuel, then boost the price. Is there no limit? Can they always do just as they like while the consumers take it as handed to them, without remarks?

I cannot believe that the business is now being handled rightly, as the coal comes wet or dry—many times very wet—and our good money is paid for it just the same. Suppose the rate for light and heat is based on the former prices and then the price of coal is more than doubled and at the same time the quality reduced; what can be done about it?

The laws compel the druggists to label every package as to just what the formula is; the merchant also is obliged to have his scales balanced, measures registered and sealed so as to sell by a standard; but the coal men are not so closely supervised.

The chemical test as now performed is not satisfactory; in fact, it cannot at present be used, as the dealers will not stand for it, and the consumer can take what they have and pay the price or leave it. Will we have to stand for this always? Cannot there be some protection given, some standards adopted so as to get nearer the required quality and weight, in this big and growing expense?

Binghamton, N. Y. ASA P. HYDE.

Inquiries of General Interest

Disadvantages of Excessive Lap of Corliss Steam Valves—On a Corliss engine why is excessive lap of the steam valves objectionable? R. C.

The disadvantage of excessive lap on the steam valves is that it reduces the rapidity of movement of the valves at the point of opening and diminishes the range of cutoff.

Short-Stroking of Pump Wasteful of Steam—Why does a duplex steam pump require more steam for a given service when there is less lost motion of the valve gear? R. C.

By lessening the lost motion, the length of stroke is shortened and a larger proportion of the steam that is supplied is wasted in filling clearance spaces of the steam cylinder.

Insufficient Cushioning When Running Condensing—For quiet running, what alteration should be made in the valve setting of an engine when changed from noncondensing to condensing? C. W. S.

For obtaining the same cushioning effect from compression of the exhaust when running condensing as when the engine was operated noncondensing, the exhaust valves need to be closed considerably earlier in the exhaust stroke.

Absorption of Heat of Friction in Refrigerating Coils—How much heat would be absorbed from pipe friction in pumping brine through pipe coils at the rate of 1.52 cu.ft. per min. where the drop in pressure is 6 lb. per sq.in.? R. L. Y.

Assuming that the pressure readings are made at the same level, a displacement at the rate of 1.52 cu.ft. per min. and a drop in pressure of 6 lb. per sq.in. would represent an absorption of $1.52 \times 144 \times 6 = 1313.28$ ft.-lb. of energy, or $1313.28 \div 778 = 1.68$ B.t.u. per min.

Transformer Explosions—What is the cause of oil-filled transformers exploding, and what precautions may be taken to prevent such occurrences? T. O. A.

The usual cause of explosions in oil-insulated transformers is an accumulation of inflammable gases between the surface of the oil and the cover of the transformer, and the gases thus formed explode when ignited. Ignition is generally caused by an arcing or corona on the leads above the oil surface. About the only safeguard against these explosions is to provide the transformer tank with a vent that will allow the gases to escape before forming an explosive mixture. Modern large high-voltage transformers are equipped with vents for this purpose.

Hard Babbitt Metal for Bearings—What would be the composition of a hard babbitt metal for bearings, and how would the mixture be made? P. J. S.

A good hard babbitt metal for bearings consists of 96 parts tin, 4 parts copper and 8 parts antimony. It is mixed by first melting 12 parts copper, and then 36 parts of tin are added, after which 24 parts of antimony are added and then 36 additional parts of tin. To prevent the tin and antimony from oxidizing, the temperature should be lowered as soon as the copper is melted and the surface of the bath should be covered with pulverized charcoal. For use the alloy thus made is subsequently remelted with tin in proportions of 1 part of the alloy to 2 parts of tin.

Ground Resistance—What method can be used to test the resistance of ground connections, and what should be the resistance of a ground when properly made by driving an iron pipe into the earth? M. E. W.

The only reliable method for testing ground connections is to measure their resistance to some neighboring ground that is known to be of good quality, such as a water or gas main. The resistance is measured by passing a current from one ground through the earth into the other and measuring the current and the volts drop between the two grounds. The resistance of the two grounds will equal the volts drop between the grounds divided by the current in amperes. The resistance of a pipe ground found in this way should lie between 15 and 30 ohms, depending upon the moistness and character of the soil.

Approximate Resetting of Slipped Eccentric—If an engine's eccentric has slipped on the shaft and it is necessary to get the engine running as soon as possible and without placing the crank on a dead-center, how can the eccentric be reset quickly with sufficient exactness for running? R. C. M.

A detailed method of "Settling Eccentric Without Placing the Engine on Center" is given on page 567 of the Nov. 7, 1916, issue of Power." To reset the eccentric approximately and with sufficient accuracy for running the engine, first turn the eccentric on the shaft in the direction of rotation of the engine until the valve opening is correct for the beginning of that stroke of the piston which has been partly accomplished. Then estimate how far the crank would have to be twisted backward around the shaft to bring the crankpin on the center and set the eccentric that distance forward of the position previously determined.

Height of Return-Tubular Boiler Settings—What are the advantages and disadvantages of high settings for horizontal return-tubular boilers? B. H. F.

The principal advantages are in affording better opportunity for stoking and cleaning the fire; greater fuel economy resulting from a higher temperature and more perfect combustion by reason of the greater distance of the fuel bed from the comparatively cool surfaces of the boiler; and a deeper combustion chamber, insuring better mixture of the furnace gases before being divided up in their passage through the tubes. The principal disadvantages are increased cost of the setting on account of the increased height of the walls; presentation, in single settings, of more wall surface for loss of heat by radiation (amounting to about ½ of 1 per cent. of boiler output per foot of height); development of larger expansion cracks and greater wall area for infiltration of air; less convenience on account of greater height for cleaning the boiler; and requirement of more headroom.

Measure of Superheated Steam—How is the amount of superheating of steam designated, by percentage or by temperature, and how is the amount of superheat measured? H. B. C.

Steam is said to be superheated when the temperature is above the temperature of the boiling point corresponding to its pressure. The number of degrees by which the actual temperature exceeds that of the boiling point, or temperature of saturated steam corresponding to the pressure, is called the "degrees of superheat," and this term is used to designate the amount of superheat. The temperature of saturated steam for any pressure may be found from steam tables. The actual temperature is usually determined by observing the temperature indication of a mercury thermometer with the bulb end immersed (to a mark on the stem) in a bath of oil or mercury contained in a thermometer-well inserted in the space containing the steam whose temperature is to be taken. Thus, if the gage pressure of the steam is 100 lb. per sq.in. and the thermometer shows that its temperature is 428 deg. F., then since the temperature of saturated steam at a pressure of 100 lb. gage, or 115 lb. absolute, is about 338 deg. F., there would be $428 - 338 = 90$ degrees of superheat.

Coking and Alternate Methods of Firing—What is the difference between the coking and the alternate methods of hand-firing with bituminous coal? J. R.

In the coking method, the fresh coal is placed just inside of the furnace door and allowed to remain there until the heat of the fire drives the hydrocarbons out of the coal. While this is in progress a quantity of air, that is adapted to the stage of the combustion, should be allowed to enter through the fire-door openings. As the hydrocarbons are driven off, they become mixed with the air and burn in passing over the hotter portions of the fire. After the volatile matter has thus been removed from the coal, the remainder is in the form of coke, which is to be pushed back into the hotter portions of the fuel bed where combustion of the fuel is completed. A fresh supply of coal is then placed in the front of the fire, and the process of coking is repeated.

In the alternate method of firing, fresh coal is fired in a thin layer, first on one side of the grate and then on the other, and combustion of the volatile matter and burning of the carbon are continuous, without the disadvantage of stirring up the fire, as when the coke is pushed back, and without changing the air supply to correspond with different stages of the combustion, as required for best results with other methods of firing.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Boston Edison Plant Discussed

An extended analysis of the adequacy of the generating plant of the Edison Electric Illuminating Co., of Boston, was a feature of hearings before the Massachusetts Gas and Electric Light Commission Jan. 15 and 16, in connection with a price arbitration for street lighting in Boston. Reginald J. S. Pigott, power superintendent of the Remington munitions companies at Bridgeport, Conn., was called as an expert by the City of Boston. The entire day of Jan. 15 was devoted to testimony to the effect that the capacity of the L Street Station of the Boston Edison company, South Boston, was excessive for the load requirements at the end of 1914, the basis from which street-lighting costs are being figured. Cross-examination of the witness by F. M. Ives, counsel for the Edison company, took place Jan. 16.

Mr. Pigott said that the two stations of the Interborough Rapid Transit Co., of New York, had in 1913 a combined installed capacity of 172,500 kw., and with simultaneous peaks resulting from railway service, the combined peak was 149,000 kw., giving 23,500 kw. reserve, or 15.8 per cent. of the combined peak. Mr. Pigott stated that the low-pressure turbines at Fifty-ninth Street were built at a time when it was customary to give more generous margins in capacity of generators than at present, and that these machines were fairly comparable, with respect to overload capacity, to the 7500-kw. and 12,000-kw. turbine units at L Street. One of the 7500-kw. Boston Edison turbines could be run at 8500 kw. for an hour without distress, and the 12,000-kw. units ought to be safe, he said, at 12,750 kw.

Omitting the six 1500-kw. engine-driven alternators at L Street, the remaining units of the earlier turbine type rated at 96,000 kw. could be pushed to deliver 100,250 kw. for an hour, making no allowance for overload capacity in the three 15,000-kw. turbo-units then installed. Illustrating the spare capacity available in the earlier turbines, Mr. Pigott said that the Interborough company had a machine in 1905 which was rated at 5000 kw., the rating afterward being raised to 7500-kw. maximum, and that this machine has actually been operated during a period of three hours at 9000 kw., during which time the relay valve never opened, showing that the steam end of the unit had a still further margin, although it was not thought wise to force the generator beyond this point.

One unit of the largest size installed in the station, over and above the peak load, the witness held, is a fair margin of reserve capacity for a system like that of the Boston Edison company. Specifically, this would be expressed as the peak load plus 15,000 kw., in the Boston case. In a station of heterogeneous sizes of units, the reserve must be increased somewhat in percentage compared with a plant of uniform unit sizes, because the largest machines installed must be provided for as to the reserve. The amount of reserve carried above the peak capacity has nothing to do with the kind of load being handled. The only real difference between railway and lighting peaks in a large city is that the latter occurs at a different time of day from the former, and sometimes with greater suddenness, than most railway loads.

Quoting a discussion of a paper by Stott and Gorsuch, "Standardization of Method for Determining and Comparing Costs in Steam Plants," A. I. E. E., 1913, the witness said that Peter Junkersfeld, of Chicago, maintained that in figuring investment costs, spare capacity is a large item. Under some conditions 10 per cent. spare capacity may suffice; in some situations 20 per cent. is too close, especially where the business is rapidly growing. This does not mean that the company always carries 20 per cent., but that it is the figure if everything goes well. If there are labor troubles or manufacturing difficulties, that 20 per cent. may go down in one year to 5 per cent.

The system peak on the Boston Edison's plants at L Street and Atlantic Avenue in December, 1914, was 65,342 kw., the peak at L Street being 60,100 kw. Mr. Pigott said that 75,100 kw. would be the adequate capacity of the station to take care of this load, although with the existing physical equipment it was not possible to get exactly this figure. In the witness' opinion, the 9000-kw. reciprocating-engine plant and the last 15,000-kw. turbo unit could safely have been eliminated, leaving 81,000 kw. in installed capacity in the L Street Station. Mr. Pigott said that the whole theory of reserve capacity is based upon the probabilities of losing more than one unit in a station at a time, which are very remote.

The L Street units, excluding the 15,000-kw. machines, would carry 7 or 8 per cent. more load than the 81,000 kw. mentioned. The necessary units for handling the peak of 60,100 kw. with adequate reserve were two 7500-kw., three 12,000-kw. and two 15,000-kw. units, in Mr. Pigott's opinion, affording a reserve of about 32.5 per cent. of the peak. This position is strengthened by the possibility of further using about 3600 kw. in steam-generating capacity in the Atlantic Avenue Station, which is available for breakdown service. Even considering the latter station, the total load was 65,342 kw. and the total installed capacity, considering the L Street Station today with engine plant and eighth 15,000-kw. unit, leaves a reserve of over twice the largest unit. Also a tie line between the Edison L Street Station and the South Boston Station of the Boston Elevated Railway, offers 9000 kw. more through a frequency-changer set. In July, 1916, the company connected a tie line to the 1400-kw. hydro-electric plant of the Metropolitan Water Board at Sudbury, Mass. In the winter of 1915 the peak load on L Street totaled 67,700 kw. with the same installed capacity of 105,000 kw. The street-lighting load for 1914 was 3223 kw. for arc lamps and 309 kw. for incandescent lamps, in Boston proper. In the witness' opinion, the last two turbines were installed at least a year too soon.

The witness estimated the investment cost of the L Street Station as of 81,000-kw. capacity (his opinion of the safe total rating for the 1914 conditions) at $5,315,396. Coal-handling machinery within the building was figured at 59c. per kw. Property outside the station under lease to C. H. Sprague, a coal contractor, who supplies the company, and including the entire external coal-handling apparatus and storage facilities, was deducted. The entire coal-handling system, based on the witness' experience should not exceed 80c. per kw. The witness said that the rental received from the Sprague coal establishment has not been applied to reducing the cost of power or to reducing the cost of coal. Mr. Pigott said that the cost of rebuilding the first two 7500-kw. turbine units for 12,000-kw. output at L Street was unwarranted. The total cost of the two units originally was $299,621, including foundations and auxiliaries; and the cost of reconstruction was $294,625, or a total of $594,247 for the two units rebuilt to 12,000-kw. capacity each, so far as the witness could ascertain from the company's cost data filed with the commission. Similarly, he estimated the cost of two new 12,000-kw. machines at $461,730, leaving a net in favor of purchasing new machines of $132,517.

SUBSTATION EQUIPMENT INCLUDED

A further elimination of $512,650 corresponds to the cost of the 15,000-kw. turbo unit deemed unnecessary, and $1,245,014 was also deducted, representing the cost of the 9000-kw. engine-driven plant at L Street, which the witness declared superfluous with respect to 1914 load demands. The cost of Brush arc generators (motor-driven) at $154,918 was taken out, as this should have been made a substation charge instead of a charge on the generating plant, in the opinion of the witness. This portion of the L Street property was not required in 1914 for any purpose except to house Brush arc machines, which are substation equipment, and the witness said that his opinion holds the same today, as there is enough equipment in the turbo station as it stands, with the tie line and Sudbury connections, to take care of increases on the 1915 and probably on the 1916 load, within the required limits of reserve. The total deductions made by the witness figure $2,408,723, and the estimated cost of the 81,000-kw. station capable of handling the Boston Edison load with the reserve specified by the witness was $65.60 per kw., exclusive of coal-storage facilities outside the plant. The land area at L Street is much larger than is usual for a plant of this size, and the unit cost of $65.60 per kw. is rather high, said the witness. A total figure, including outside coal-handling and storage equipment, with land for the latter, might be $66.60 per kw.

Taking up the cost of various equipment items, Mr. Pigott stated that certain of these appeared excessive in comparison with usual practice. The unit cost of eight B. & W. boilers to the company in 1903 was $12.53 per horsepower against $11.50 from similar contracts on the same-sized boilers and in about equal quantities around the same date. The difference amounts to about $2200 for the boilers alone. On the entire station the excess cost of apparatus over normal costs figures $298,556, according to Mr. Pigott, or about 20 per cent. above normal. The witness said that the 7500-kw., maximum-rating machines which cost the Boston company $100,000 each, were purchased in exactly similar units by the Commonwealth Edison Co. of Chicago for $87,500, for the Fiske Street Station. On the 12,000-kw. unit bought in 1907 a similar 12,000-kw. set cost $140,000, as against $168,500 for Boston.

Mr. Pigott then referred to the coal contracts of the Boston company with C. H. Sprague, dated March, 1913, for one year, and Sept. 1, 1915, for five years. The former called for $2.85 per ton for run-of-mine coal and $2.70 for nut and slack. The latter contract calls respectively for $2.75 and $2.65 per ton.

The generating cost at L Street for the year ended Nov. 30, 1914, was 0.48c. per kw.-hr., which the witness considered an excellent result for the combination of equipment installed. The ratio of coal cost to total cost (about 75 per cent.) was

in accord with the best practice. The use of underfeed stokers, however, in the opinion of the witness, would have cut the cost of production per kilowatt-hour 7 or 8 per cent. and would have reduced the coal cost from 10 to 12 per cent.

Under cross-examination by F. M. Ives, counsel for the Boston Edison company, Mr. Pigott stated that the cost of production at the Fifty-ninth Street Station of the Interborough Rapid Transit Co., for the three years preceding the change from engine-driven units to combination engine and low-pressure turbines, was 0.49c. The station cost about $150 per kw. of capacity, as originally laid out, but the low-pressure turbine installation brought down this cost to $87.50 per kw. The original layout of the Seventy-fourth Street Station, consisting of eight 7500-kw. engine-driven units, cost about $120 per kw. Regarding reserve capacity Mr. Pigott said that while in general a capacity equal to the largest unit in excess of the peak is the rule, in cases where stations are tied together the reserve can be cut down. He felt that in the case of the Commonwealth Edison Co. of Chicago, a reserve of 30,000 kw. should be sufficient. Mr. Ives brought out the point that the peak load of the Commonwealth Edison Co. is about 370,000 kw. and that over 200,000 kw. of additional capacity is now on order for immediate installation. Mr. Pigott said that possibly the Chicago company anticipates a very large additional demand for power, as the reason for this order. Mr. Ives asked the witness if just prior to 1914 negotiations had almost been closed for the sale of 20,000 kw. to the New York, New Haven & Hartford R.R. by the Boston company, his opinion would change relative to the providence of ordering the eighth turbine of 15,000-kw. rating. Mr. Pigott said that he would reconsider the figures with this additional load in view, but that this would not explain the amount of reserve carried over a period of five years.

Mr. Ives inquired whether the witness thought he knew more about the needs of the Boston company with respect to capacity for serving customers and increasing demands than President C. L. Edgar, I. E. Moultrop, its assistant superintendent of construction, and L. L. Elden, its electrical superintendent. Mr. Pigott said in reply that in so far as these gentlemen are acquainted with the details of the business, he would say that they are better fitted to express opinions upon the service to customers, but that so far as matters affected the design of a power station, he felt equally competent to express an opinion. The witness conceded that the limitation of turbo-generator connection to different buses in the L Street Station for the supply of energy at 2300, 6900 and 13,800 volts might make a difference in his opinion as to what the proper reserve was and how it should be distributed, depending upon the capacity of the transformers connecting the different buses. In an assumed case of loads offered by counsel for the company, Mr. Pigott refused, after several calculations, to withdraw his original opinion that the capacity of the station at L Street was excessive for the load.

Heating and Ventilating Engineers' Annual Meeting

The twenty-third annual meeting of the American Society of Heating and Ventilating Engineers was held at the Engineering Societies Building, New York, Jan. 16, 17 and 18. The forenoon of Tuesday, the 16th, was devoted entirely to registration of members and guests and a general get-together period, with the exception of a meeting of the council, which began at 10:30.

The afternoon session was devoted to business. Reports of committees were presented, including that of the tellers of the election of officers for the ensuing year, which announced the election of Irvine J. Lyle, president; Arthur K. Ohmes, first vice-president; Fred R. Still, second vice-president; Homer Addams, treasurer (reëlected). Following the transaction of routine business, one paper, "Railway Passenger-Car Heating," by E. W. Rietz, was read and discussed.

In the evening the following professional papers were presented and discussed: "Some Notes on Warm-Air Furnace Heating," by Jesse M. McHenry; "Symposium on Methods of Testing Heating Boilers," Report of Committee of New York Chapter, presenting the subject for discussion.

At the third session, on Wednesday morning, the greater part of the time was devoted to consideration of "The Durability of Materials for Conveying Steam, Water and Air" and "Method for Practical Elimination of Corrosion in Hot Water Supply Pipes," the latter by F. N. Speller. "Windows," by Dr. E. V. Hill, started considerable discussion on heat transmission through various types of sash.

During the afternoon session "The Transmission of Steam in a Central Heating System," by J. H. Walker; "Efficiency of Underground Conduit," by George B. Nichols, and "An Improvement in Ventilating Apparatus," by William J. Baldwin, received careful attention, and all were freely discussed, as well as the set topic for discussion, "Use of Humidifiers in Connection with Direct Radiation."

The session on Thursday morning was devoted to the following papers on drying: "Drying by Evaporation," by F. R. Still; "Artificial Drying with Special Reference to the Use of Gas," by G. C. Shadwell, and "Drying in Industrial Plants," by J. O. Ross.

At the closing session, Thursday afternoon, papers on "Heating and Ventilating Equipments of the Philadelphia Public School Buildings," by J. D. Cassell; "Heating and Ventilating a Portable Schoolhouse," by J. R. McColl, and "Remodeling the Ventilation of a Theater," by S. R. Lewis, occupied all the available time except that devoted to the installation of officers for 1917. The entire meeting was a splendid success from a professional and social point of view.

The program of entertainment for the ladies and guests was well planned and carried out. Following registration at the Engineering Societies Building the party was conducted to the Rialto Theater and in the evening to dinner at Churchill's. On Wednesday afternoon a theater party at the Thirty-ninth Street Theater was followed by a dinner and dance in the evening at the Hotel Astor. A trip to Wanamaker's, including luncheon and an organ recital with a special musical program, constituted part of Thursday's program, and guides were in readiness to escort parties to any desired points of interest.

ENGINEERING AFFAIRS

The Engineers' Club of St. Louis and Associated Engineering Societies held their annual dinner at the City Club on Wednesday evening, Jan. 24. It was well attended and proved a big success.

The American Society of Steam Boiler Inspectors of New York City will hold its seventh annual banquet on Feb. 24, at the Marlborough Hotel, 36th St. and Broadway, at 8 p.m.

Eccentric Firemen's Annual Ball—The International Brotherhood of Stationary Firemen, Local No. 56, held its annual entertainment and ball at the Central Opera House, 205 East 57th St., on the evening of Jan. 13. As is the rule on these occasions a high-grade vaudeville performance is given during the early part of the evening, and this is followed by dancing—one floor being devoted to the popular dances, while another is for the use of those who prefer the older styles and the "folk dances" of Erin. Mayor Mitchel and other New York City officials were present. International President Timothy Healy stated from the platform that the foremost objective engaging the attention of Local No. 56 at present is that of procuring for firemen in the city employ a six-working-day week instead of the present seven-day duty.

The Chicago Section A. S. M. E. on Friday evening, Jan. 19, held its second regular meeting of the season at the La Salle Hotel. "Problems in Waste Disposal" was the topic, and the speaker of the evening was Col. Henry A. Allen, consulting engineer, Garbage-Disposal Plant, City of Chicago. With a wealth of lantern slides and detailed information, Colonel Allen spoke on the methods followed by the city in acquiring and appraising the privately owned plant of the Chicago Reduction Co. He reviewed the work of revamping this plant and spoke of the additions made by the city, showing in detail what had been already accomplished and the plans for the future. In the course of his remarks he outlined the principle methods of garbage reduction in use, enumerated the by-products that were and might be recovered and compared the present with former costs per ton to the city of disposing of the garbage. Considerable attention was given to the equipment for collection and conveyance to the plant.

Improving Conditions in Municipal Power Plants—At a meeting held in Indianapolis, Ind., on Jan. 9, a state association for improving conditions in municipally owned plants was organized by city officials and superintendents of municipally owned utilities of Indiana. Representatives of several cities attended and suggested that at the next meeting a constitution be drafted, a name be given to the association and a legislative program be formulated for presentation by a committee to the general assembly, asking the passage of an amendment to the public-utilities act providing that cities be permitted to control municipally owned utilities. Frank J. Dix, of Ft. Wayne, Ind., was elected president of the organization and John J. Alt, of Ft. Wayne, secretary-treasurer.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points are as follows:

ANTHRACITE

	Circular		Individual	
	Jan. 27, 1917	One Year Ago	Jan. 27, 1917	One Year Ago
Buckwheat	$3.60	$3.10	$6.00@6 50	$3.00@3.50
Rice	3.10	2.50	5.50@5.75	2.60@3.00
Boiler	2.95	....	5.00@5 25	.....
Barley	2.85	2.25	4.20@4.60	2.45@2.60

BITUMINOUS

Prices per gross ton for Boston delivery:

	F.o b. Mines All-Rail Rate $2.60 to Boston		Alongside Boston Water Coal	
	Jan. 27, 1917	One Year Ago	Jan 27, 1917	One Year Ago
Clearfields	$4.75@5.60	$4.00@4.50	$8.25@8.50	$5.60@5.75
Cambrias and Somersets	5.00@6.25	4.25@4.75	8.35@8.75	.....
	F.o.b. Hampton Roads		On Cars, Boston	
	Jan. 27, 1917	One Year Ago	Jan 27, 1917	One Year Ago
Pocahontas and New River	$6 50@7.00	$2.85@2.90	$9.50@9.75	$6.25@6.75

New York—Current quotations per gross ton f o.b. Tidewater at the lower ports are as follows:

ANTHRACITE

	Circular		Individual	
	Jan. 27, 1917	One Year Ago	Jan. 27, 1917	One Year Ago
Buckwheat	$2.75	$2.75	$6.00@6 25	$4.00@4.15
Rice	2.20	2.25	4.50@5.25	3.40@3.50
Barley	1.95	1.75	3.50@4 00	2.50@2.90

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	South Amboy		Port Reading	Mine Price	
	Jan. 27, 1917	One Year Ago	Jan. 27, 1917	Jan. 27, 1917	One Year Ago
Clearfield	$6.75@7.00	$4.15@4.55	$6.75@7.00	$4 50@5.25	$2.75@3.00
South Forks	6.75@7.00	4.30@4.55	6 75@7.00	4.50@5.25	2.75@3.00
Nanty Glo	6.75@7.00	4.30@4.55	6.75@7.00	4.50@5.25	2.60@3.00
Somerset	6 75@7.00	4.15@4.40	6.75@7.00	4.50@5.25	2.50@3.00
Quehamoning	6.75@7.00	4.15@4.40	6.75@7.00	4.50@5.25	2.75@3.00

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Jan. 27, 1917	One Year Ago	Jan. 27, 1917	One Year Ago
Buckwheat	$2.00	$1.55	$2.90	$2.30
Rice	1.25	.90	2.15	1.80
Boiler	1.10	....	2.00	....
Barley	1.00	.55	1.90	1.30

Birmingham—Current prices per net ton f o.b. mines:

	Mine-Run	Washed Mine-Run	Washed Nut
Pratt	$3 00	$4.50	$4.50
Big Seam	2.50	$3.75@4.25	$3.75@4.25
Black Creek	$3.00@3.25	4.50	4.50
Carbon Hill	2.50	4.00	4.00
Cahaba	3 50	4.50	4.50

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Jan. 27, 1917	One Year Ago
Slack	$4.00@4.50	$1.35@1 60
Mine-run	4.50@4.75	1.50@1.75
¾-in.	4.50@4.75	1.60@1.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b mines:

	Springfield	Clinton and Sullivan Cos.
Steam lump	$3.25@3 50	$3.25@3.50
Egg	3.50@4.00	3.25@3.50
Nut	3.25@3.50	3.25@3.50
Mine-run	3.25@3.50	3.25@3.50
Screenings	3.00@3.50	3.25@3.50

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless
Lump	$3.75@4.00	$3.50@4.00	$5.25@6.25
Egg	3.75@4.00	3.50@4.00	5.25@6.25
Nut	.....	3.25@3.50	.....
No. 1 nut	3.75@4.00	.....	.....
No. 2 nut	3.50@3.75	.....	.....
No. 3 nut	3.25@3.50	.....	.....
No. 1 washed	3.75@4.00	.....	.....
No 2 washed	3.25@3.75	.....	.....
Mine-run	3.25@3.50	3 25@3.50	5.25@5.50
Screenings	3.25@3.50	3.25@3.50	.....

Hocking lump, $3 75@4; splint lump, $3.75@4.

St. Louis—Price per net ton f.o.b. mine:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Jan. 27, 1917	One Year Ago	Jan. 27, 1917	One Year Ago	Jan 27, 1917	One Year Ago
6-in. lump	$3.25@3.50	$1.60@1.75	$3@3.25	$1.35@1.50	$2.50@2.75	$1.25@1.35
2-in. lump	.....	1.40@1.50	.....	1.25@1.35	2.25@2.50	1.15@1.25
Steam egg	.....	.....	3@3.25	.....	2.25@2 50	.....
Mine-run	3.00@3.25	1 15@1.20	3@3.25	1.10@1.15	2.25@2.50	1.10@1.15
No. 1 nut	.....	1.25@1.40	.....	.....	.....	1.10@1.25
2-in. screen. No. 5	3@3.25	.75@ .85	.....	.75@ .85	2.25@2.50	.75@ .85
washed	3.00	1.35@1.50	2.75	1.35@1.50	.....	1.25@1.40

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

PROPOSED CONSTRUCTION

Ga., Valdosta—The Valdosta Lighting Co. plans to improve its power station. Estimated cost, $100,000. W. E. Eager, Gen. Mgr.

Idaho, Kendrick—The Potlatch Consolidated Electric Co. has been granted a franchise to construct transmission lines on county highways.

Ill., Fairfield—Plans are being considered by the Commissioners of Wayne County for the installation of a power plant in the county building. Address County Clk., Fairfield.

Iowa, Maquoketa—The citizens have voted in favor of a bond issue to install an electric-light plant.

Kan., Elk City—W. W. McDaniels, Terlton, Okla., plans to build an electric-light plant at Elk City.

Kan., Mound Valley—The Prairie Oil and Gas Co. plans to construct a power plant.

Ky., Ft. Scott—The citizens voted $15,000 bonds to install an electric-light plant.

Ky., Hazard—The city plans to improve its electric-light plant. Estimated cost, $20,000.

La., Edgerly—A company has been organized to install an electric-light and power plant in Edgerly. L. Alford is interested.

La., Shreveport—The Southwestern Gas and Electric Co. plans to enlarge its power house. Estimated cost, $100,000. A. G. Curtis, Mgr.

Mich., Gladstone—The Board of Fire and Water Commissioners plans five miles of 6600-volt transmission line and electrically driven pumps of 100,000-gal. capacity. J. R. Macklin, Supt. of the light and water systems.

Minn., Hopkins—Bids will be received by the city until Feb 13 for a gas plant. F. C. Shepherd, 16 South Seventh St., Minneapolis, Engr.

Minn., Sauk Center—The city voted $50,000 bonds to install an electric-light and power plant.

Mo., Fulton—The State Legislature has been petitioned by the Fulton State Hospital to make an appropriation to install a new power plant.

Mo., Grandview—The city plans to install an electric-light plant.

Mo., Springfield—An election will be held in the city Feb. 28 to vote on a bond issue for $400,000 to install an electric-light plant. Stevens & Stiles, Commerce Building, Kansas City, Engr.

Neb., Winside—The citizens have voted in favor of a bond isssue for $7500 to install an electric-light plant.

N. J., Atlantic City—The Atlantic City Electric Co. has been granted permission by the Board of Utility Commissioners to issue $137,000 bonds to improve its power station and system.

N. J., Seaside Park—Bids will be received by A. Wilbert, Boro. Clk., until Feb. 3 for completing the installation of a new 125-hp. boiler, new 250-hp. heater, new 75-kw. generator and four-valve shaft governor 257-revolution engine, etc. C. W. Mathis, Mayor.

N. Y., Auburn—Plans have been prepared by Robinson & Hillger, Arch., Seward Building, for a one-story, 42x47-ft. boiler house for Auburn Theological Seminary.

N. Y., Buffalo—The Central Star Laundry plans a power plant at 21 Northland Ave. R. J. Reidpath & Son, Builders' Exchange, Arch.

N. Y., New York—(Borough of Manhattan)—Bids will be received by the Department of Health in the spring for a two-story, 512x786-ft. brick and concrete heating plant at 15th St. and Ave. C. Estimated cost, $125,000. W. E. Austin, 46 West 24th St., Arch.

N. C., Spring Hope—Plans are being considered by the city for the improvement of its electric-light plant.

Ohio, Bluffton—City plans election Mar. 6 to vote on $35,000 bonds to improve its electric-light plant.

Okla., Haskell—The citizens have voted in favor of a bond issue for $20,000 to install an electric-light plant.

Ont., Oil Springs—Citizens voted in favor of a by-law for $10,000 to build a hydro-electric plant. D. P. Sisk, Clk, Hydro-Electric Commission.

Ore., Stayton—The Stayton Electric Light Co. plans to improve its plant. C. E. Taylor, Owner and Mgr.

Penn., Norristown—The Counties Gas and Electric Co. has purchased a site at Swede and DeKalb St. for additions to its plant. J. A. Pearson, Pur. Agt.

Penn., Palo Alto—(Pottsville post office)—Eastern Pennsylvania Light, Heat and Power Co. plans to rebuild its electric power plant which was recently destroyed by fire at a loss of $500,000. C. A. Greenidge, 43 Exchange Place, New York, Pres.

Tex., Beaumont—The Beaumont Traction Co. plans to build an electric transmission line from Beaumont to Port Arthur, and also increase the output of the two plants.

Tex., Dallas—The Commissioners of Dallas County plan to add another unit to the power plant in the Criminal Courts Building. Estimated cost, $12,000. Address County Clk., Dallas.

Tex., Denton—The Acme Pressed Brick Co. plans to rebuild its power plant recently destroyed by fire with a loss of $12,000. W. R. Bennett, Pres.

Vt., Montpelier—The Montpelier & Barre Light and Power Co. plans a 2300-volt single-phase transmission line from North Montpelier to East Calais, 4.5 miles.

Wash., Olympia—The City Council has granted the American District Steam Co., Tonawanda, N. Y., a franchise to install an electric-light and power plant.